US Productivity Growth 1995-2000

Understanding the contribution of Information Technology relative to other factors

McKinsey
Global
Institute

With assistance from our Advisory Committee
B. Solow, chairman, B. Bosworth, T. Hall, J. Triplett

Washington, DC
October 2001

McKinsey Global Institute

The McKinsey Global Institute was established in 1990 as an independent research group within McKinsey & Company, Inc. to conduct original research on important global issues. Its primary purpose is to develop insights into global economic issues and reach a better understanding of the workings of the global economy for the benefit of McKinsey clients and consultants.

From time to time the Institute issues public reports. These reports are issued at the discretion of the Institute's Director and its McKinsey Advisory Board, when they conclude that the Institute's international perspective and its ability to access McKinsey's knowledge of industry economics enable it to provide a valuable fact base to policy debates. The McKinsey Advisory Board is made up of McKinsey partners from Europe, the Pacific Basin and the Americas.

The staff for the Institute are drawn primarily from McKinsey's consultants who serve 6-12 month assignments and then return to client work. The Institute also commissions leading academics to participate in its research. The Institute's Director is William Lewis, a McKinsey partner. The Institute is located in Washington, D.C.

Contents

Preface

This report is the product of a year-long project by the McKinsey Global Institute, working in collaboration with McKinsey's High Tech practice and San Francisco office. The objective of the project was to determine what caused the sudden increase in the rate of growth of labor productivity in the United States after 1995.

McKinsey undertook this project as an important step towards developing our understanding of how the global economy works. The dramatic improvement in economic performance in the United States in 1995 embodied two main elements. The first was the unusual combination of extremely low levels of unemployment and low inflation. The second was the sharp increase in the rate of growth of labor productivity. These were the fundamental factors that led to the claim that the United States had a "New Economy."

The first element is being addressed in particular by Robert Solow and Alan Krueger in a project for the Russell Sage Foundation. The results of this project will be released in early 2002. Our objective was to understand the second element: what caused the increase in the labor productivity growth rate and would it be sustainable. In particular, we wanted to understand the contribution of information technology relative to other factors. We have evaluated the sustainability of the increased productivity growth rate in the context of a possible near-term recession in the U.S.

This project differs from the projects conducted by the McKinsey Global Institute during the past ten years. The previous projects addressed the reasons for differences in productivity levels across the major economies of the world.[1] The objective of this project was to understand the reasons for a change in the growth

---

1 *Service Sector Productivity*, McKinsey Global Institute, Washington, D.C., October 1992; *Manufacturing Productivity*, McKinsey Global Institute, Washington, D.C., October 1993; *Employment Performance*, McKinsey Global Institute, Washington, D.C., November 1994; *Capital Productivity*, McKinsey Global Institute, Washington, D.C., June 1996. *Sweden's Economic Performance*, McKinsey Global Institute, Stockholm, September 1995; *Australia's Economic Performance*, McKinsey/Australia and McKinsey Global Institute, Sydney, November 1995; *Removing Barriers to Growth in France and Germany*, McKinsey Global Institute, March 1997; *Boosting Dutch Economic Performance*, McKinsey Global Institute and Max Geldens Foundation for Societal Renewal, September 1997; *Productivity-The Key to an Accelerated Development Path for Brazil*, McKinsey Brazil Office and McKinsey Global Institute, Sao Paulo, Washington, March 1998; *Productivity-led Growth for Korea,* McKinsey Seoul Office and McKinsey Global Institute, Seoul, Washington, March 1998; *Driving Productivity and Growth in the U.K. Economy,* McKinsey London Office and McKinsey Global Institute, October 1998; *Unlocking Economic Growth in Russia*, McKinsey Global Institute, October 1999; *Poland's Economic Performance*, McKinsey Global Institute, March 2000; *Why the Japanese Economy is not Growing: micro barriers to Productivity Growth*, McKinsey Global Institute, July 2000; *India: The growth imperative; Understanding the Barriers to Rapid Growth and Employment Creation,* McKinsey Global Institute, September 2001.

rate of labor productivity within one country. Given the inconclusive nature of traditional economic approaches to analysis of this issue, we thought that our unique microeconomic approach using sector case studies might be successful in resolving this issue.

This report consists of an executive summary, eleven chapters and an appendix. The first three chapters, Objectives and Approach, Synthesis, and Prospective scenarios provide an overview of our methods and our conclusions. They can be read as a stand-alone summary of our work. The following eight chapters provide our case studies on retail trade, wholesale trade, semiconductor manufacturing, computer manufacturing, telecommunications services, securities, retail banking, and hotels. Each of these cases has a brief summary in the beginning.

A core group of ten consultants from McKinsey's Global Institute, High Tech practice, and Los Angeles, San Francisco and Silicon Valley offices made up the working team for this project. The consultants, with the sections of the report to which they contributed, were: Angelique Augereau (wholesale, synthesis, and objectives and approach); Mike Cho (computer manufacturing, synthesis, and objectives and approach); Brad Johnson (retail); Brent Neiman (semiconductors and holdings measurement); Gabriela Olazabal (retail banking); Matt Sandler (software measurement); Sandra Schrauf (synthesis); Kevin Stange (hotels, prospective scenarios, and automotive measurement); Andrew Tilton (telecommunications and prospective scenarios); and Eric Xin (securities). Leslie Hill Jenkins and Cindy Neil provided administrative assistance to the team.

Baudouin Regout and Allen Webb were responsible for day-to-day management of the project. This project was conducted under the direction of Mike Nevens, Lenny Mendonca, Vincent Palmade, and myself, with assistance from Greg Hughes and James Manyika. In carrying out the work we were fortunate to have an external advisory committee. The committee members were Robert Solow – MIT, chairman; Barry Bosworth, Brookings Institution; Ted Hall, retired McKinsey partner; and Jack Triplett, Brookings Institution. The working team had four all-day meetings with the advisory committee to periodically review progress during the course of the project and benefited from many written comments and individual discussions. McKinsey remains solely responsible for the content of this report.

Throughout the project we also benefited from the unique worldwide perspective and knowledge that McKinsey consultants brought to bear on the industries researched for our case studies. Their knowledge was a product of intensive work with clients and a deep investment in understanding industry structure and behavior to support client work. McKinsey sector leaders provided valuable input to our case studies and reviewed our results. McKinsey's research and information department provided invaluable information insight while working under trying deadlines. Tim Beacom, in particular, was involved with this effort from start to finish. Finally, we could not have undertaken this work without the information we received from numerous interviews with corporations, industry associations, government officials, and others. In particular, the Bureau for Economic Analysis at the US Department of Commerce, the Bureau of Labor Statistics at the US Department of Labor, the Census Department and the US Internal Revenue Service were especially helpful. We thank all those who gave of their time and help.

Before concluding, I'd like to emphasize that this work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution.

Bill Lewis

Director of the McKinsey Global Institute

October 2001

Executive Summary

The terrorist attacks of September 11 sent shock waves throughout the US economy, putting the debate about the "new economy" on hold and shifting the focus to a looming recession. While we cannot predict how consumer and business demand will evolve, we do have some good news. Our year-long research shows that many of the product, service, and process innovations underlying the US productivity improvement that began in 1995 will continue to generate productivity growth above the long-term, 1972-95 trend. However, the growth rate will probably not be as high as the 1995-2000 rate.

Before the attacks, there was much discussion of what caused US productivity to accelerate after 1995. From 1995 to 2000, labor productivity grew at an annual rate of 2.5 percent – nearly twice the 1972-95 rate of 1.4 percent. During the same years, US companies nearly doubled their pace of information technology (IT) investment (Exhibit 1). Many observers linked these trends and concluded that IT caused an increase in labor productivity throughout the economy. Our research indicates that IT was only one of several factors at work. Innovation (including, but not limited to, IT and its applications), competition, and to a lesser extent cyclical demand factors, were the most important causes. IT investments had a significant impact on productivity in some industries and virtually none in others.

Nearly all of the post-1995 productivity growth jump can be explained by the performance of just six economic sectors: retail, wholesale, securities, telecom, semiconductors, and computer manufacturing. The other 70 percent of the economy contributed a mix of small productivity gains and losses that offset each other (Exhibit 2). The existence of several "jumping" sectors is not unusual. What was unique about the late 1990s was that the jumping sectors either had very large leaps in productivity (e.g., semiconductors, computer manufacturing), or were very large in terms of employment (e.g., retail, wholesale) (Exhibit 3).

Data from the national accounts reveal a murky relationship between IT and productivity growth. The remainder of the economy beyond the six jumping sectors contributed 62 percent of the US' acceleration in IT intensity, yet many of these other sectors experienced productivity deceleration (Exhibit 4). In fact, taken as a group, the other 53 economic sectors had almost no productivity growth at all (0.3 percent annually).

If the widespread application of IT alone does not appear to explain the US productivity acceleration, what does? To answer this question, we studied the six jumping sectors, as well as three "paradox" sectors that invested heavily in IT but failed to boost their rates of productivity growth (hotels, retail banking, and long-distance data transmission). We wanted to see what sparks productivity changes within firms and industries, and what role IT plays.

EXPLAINING THE 1995 PRODUCTIVITY ACCELERATION

Within the six jumping sectors, the bulk of the post-1995 productivity acceleration is explained by fundamental changes in the way that companies deliver products and services. Sometimes these innovations were aided by technology (whether new technology or old), sometimes not. In all six sectors, high or increasing competitive intensity was essential to the spread of innovation, and in two sectors, regulatory changes played an important role in increasing competition. Cyclical demand factors (the booming stock market and a shift by consumers toward higher-value goods) were important in explaining the productivity acceleration in retail, wholesale, and securities.

Structural factors: competition and innovation

The bulk of the post-1995 productivity acceleration can be traced to managerial and technological innovations that improved the basic operations of firms. Sometimes the catalyst was a dominant player with a superior business model; other times, it was managers seizing new technology to enhance their operations.

In general merchandise retailing, productivity growth accelerated after 1995 because Wal-Mart's success forced competitors to improve their operations. In 1987, Wal-Mart had just 9 percent market share, but was 40 percent more productive than its competitors. By the mid-1990's, its share had grown to 27 percent while its productivity advantage widened to 48 percent (Exhibit 5). Competitors reacted by adopting many of Wal-Mart's innovations, including the large scale ("big box") format, economies of scale in warehouse logistics and purchasing, electronic data interchange (EDI), and wireless barcode scanning. From 1995-99, competitors increased their productivity by 28 percent, while Wal-Mart raised the bar further by increasing its own efficiency another 20 percent. Although e-commerce grew rapidly during this period, its penetration rate (0.9 percent of retail sales in 2000) was still too low to make a difference in overall retail productivity. In the aggregate, the growth of Internet commerce contributed less than 0.01 percentage points to the economy-wide productivity growth jump.

The operations of wholesalers underwent similarly dramatic changes during the mid-1990s. Pharmaceutical wholesalers, for instance, responded to increasing price pressure from large retailers by automating distribution centers. Each center keeps an inventory of tens of thousands of different items; stocking, picking, and shipping this enormous variety of goods has traditionally been highly labor intensive. Relatively simple hardware (barcodes, scanners, and picking machines) combined with software (warehouse management systems for inventory control and tracking) – using largely pre-1995 IT solutions – allowed wholesalers to partially automate the flow of goods and greatly increase labor productivity (Exhibit 6).

Productivity growth in the semiconductor industry jumped from 43 percent to 66 percent because of accelerating performance improvement in the average chip sold. This was due to Intel's shortening the time between new product introductions and more rapidly enhancing the performance of each new chip, largely in response to competitive pressure from Advanced Micro Devices (Exhibit 7).

In computer manufacturing, nearly all of the productivity acceleration was due to innovations outside the sector itself. More rapid technological improvements in microprocessors and other components (memory, storage devices), as well as the integration of new components (CD ROMs, DVDs), caused the performance of assembled computers to increase at a faster rate. At the same time, the emergence of the Internet and the accelerating processing requirements of upgraded Windows operating systems caused an unusual boom in demand for more powerful personal computers that further contributed to the productivity jump in computer manufacturing and semiconductors (Exhibit 8).

The securities industry was the only one of the six jumping sectors in which the Internet materially boosted productivity. By the end of 1999, roughly 40 percent of retail securities trades were done on-line, up from virtually zero in 1995, and the same number of front-line employees could broker ten times as many trades. At the same time, firms further automated the back end of the trading process. Competition ensured the rapid diffusion of successful applications of technology as on-line discount brokers, such as E-Trade and Charles Schwab, forced traditional brokers to develop their own low-cost, on-line trading capabilities.

Specific regulatory changes increased competition and had a significant impact on productivity in two sectors. In the securities industry, the SEC's Order Handling and 16th Rules sharply reduced commissions and trading spreads. These reductions allowed institutional investors to take advantage of increasingly small price anomalies, thus boosting trading volumes and allowing the industry to leverage fixed labor. In the telecom sector, the licensing of new spectrum for mobile telephony heightened competition and sparked faster price decreases, boosting both penetration and usage. This allowed the industry to spread substantial labor costs over a larger customer base.

Cyclical demand factors: consumer behavior and stock market bubble

Some of the post-1995 productivity acceleration was due to demand factors that may not be sustainable. In the securities industry, the soaring stock market led to productivity advances in three different ways (Exhibit 9). First, lofty index values (particularly the NASDAQ's) fueled a surge in on-line retail trading. The market bubble also increased the value of assets under management, boosting the measured productivity of money managers. Finally, it boosted the number and value of initial public offerings and mergers and acquisitions. These factors explain half of the observed productivity jump in the securities industry.

Almost half of the measured productivity jump in general merchandise retail, and most likely in the rest of retail and wholesale, was due to an accelerated shift by consumers toward higher-value goods. Retail experts believe that the shift was mainly the result of growing confidence, income, and wealth, rather than a marked improvement in the way retailers entice consumers to upgrade. While these types of improvements do not reflect changes in retail or wholesale operations, they still amount to a genuine improvement in retail productivity because consumers benefit when retailers deliver goods of greater value.

THE ROLE OF IT

Our finding that a diverse set of factors – some of which were unrelated to IT – caused the 1995-99 productivity growth jump contradicts a perspective gaining ground among economists and policymakers. Contrary to conventional wisdom, widespread application of IT was not the most important cause of the post-1995 productivity acceleration.

Our nine sector case studies show that the relationship between IT and labor productivity was wide-ranging. Generally speaking, the most successful applications of IT appear to have been industry-specific applications ("verticals"), with direct impact on the core activities of the industry, as opposed to support activities.

In rare cases, IT (including communications equipment) can deliver truly extraordinary productivity improvements by expanding labor capacity by an order of magnitude. As mentioned above, on-line retail securities trading requires approximately one-tenth of the customer interfacing labor employed in traditional channels. Cellular equipment employing new digital standards allowed better use of the available spectrum and facilitated price declines. In both cases, the product or service itself was well-suited to IT because it was essentially intangible information that could be digitized.

In most cases, however, IT is just one of many tools that creative managers use to redesign core business processes, products, or services. A significant portion of Wal-Mart's business innovation (e.g., the big box format) was independent of IT. Where IT did play a role, it was often a necessary but not sufficient enabler of productivity gains. Business process changes were also necessary to reap the full productivity benefits of inventory management, electronic data interchange, and scanning systems. The same was true in the case of wholesale distribution centers, where IT was necessary for exploiting the full potential of electromechanical material handling systems.

Overall, though, IT investments do not appear to have an extraordinary impact on labor productivity. If IT impacted productivity in an unusual way, we would expect total factor productivity (TFP) growth to be positive. In fact, TFP growth was negative for the 70 percent of the economy outside of the six key, contributing sectors (-0.3 percent for the 1995-99 period, as opposed to +0.4 percent for 1987-95).[1] To understand why IT's impact was not more widespread, we looked at three sectors that invested heavily in IT but experienced slower productivity growth: retail banking, hotels, and the long-distance data portion of the telecom sector.

Many types of IT investments were made to build or maintain capabilities that would generate future productivity benefits, but not to yield immediate gains. A substantial portion of the 1995-99 increase in the real IT capital stock resulted from a coincidence of unusual events (e.g., Y2K, the emergence of the Internet, the buildup of corporate networking infrastructure, and rapid personal computer (PC) upgrade cycles) (Exhibit 10). Y2K investments were needed to ensure the continued operation of systems. Internet and networking investments were made in anticipation of substantial future benefits. PC upgrades helped ensure compatibility with emerging standards.

Information technology also can increase consumer convenience in ways not captured by government productivity measures. We found that while this did occur to a limited degree, it was insufficient to explain the "IT paradox." Hotels invested heavily in creating central reservation systems that provided some value (i.e., immediate, centralized room availability information) to customers. While this convenience was not reflected in productivity figures, its impact was probably modest. In banking, the added convenience of on-line banking does not appear in government measures. But even if it were possible to correct for this measurement issue, retail banking's decelerating productivity growth trend would not have been reversed.

It appears in fact that some IT investments are not delivering the intended results, and whether they ever will remains to be seen. Both retail banks (Exhibit 11) and hotels have collected significant amounts of customer data that they have yet to use productively. The retail banking industry bought an average of two PCs per employee between 1995 and 1999. Some of this computing power is not fully utilized and likely never will be. Long-distance telecom players made enormous investments in metropolitan and long-haul networks that are currently underutilized and are likely to remain so for several years to come.

---

[1] Total factor productivity represents improvements in labor productivity not attributable solely to increases in capital. For the economy as a whole, TFP growth was positive during 1995-99, and this fact has been cited as evidence that the application of IT contributed to widespread labor productivity acceleration. Such an interpretation is at odds with negative TFP growth in 70 percent of the economy.

In short, our findings indicate that any robust explanation for the 1995 productivity acceleration must go well beyond IT. Managerial innovations, increased competition (sometimes sparked by regulatory change), and cyclical demand factors were the more important direct causes. Moreover, our case studies indicate that, except in rare cases, IT did not produce dramatic increases in labor productivity. Rather, IT behaved much like other forms of capital, improving labor productivity simply by giving workers and managers additional tools.

WHAT'S AHEAD FOR US PRODUCTIVITY

If the patterns of the 1981-82 and 1990-91 recessions hold, the impact of a near-term recession on labor productivity over the next 4-year period will be minimal. Even if the US experiences a sharp, short-term decline in productivity growth, we would expect an uptick prior to 2005 as the economy recovers from recession.

The more important question in the longer term is whether the 1995-99 productivity acceleration will be sustainable. We estimate that at least half of the productivity acceleration in the six jumping sectors can be sustained over the next four years. Wal-Mart still enjoys a sizable productivity advantage over its competitors and will continue to force efficiency improvements in the industry. Warehouse automation (which even now has achieved only 25 percent penetration) and, to a lesser extent, mobile telephony and on-line trading, still have room for growth and will continue generating productivity gains in their respective sectors. Both the computer manufacturing and semiconductor industries should benefit from a continuation of the current rate of performance improvement in microprocessors sold.

Clearly, however, some of the productivity acceleration will be unsustainable. The unusual burst of demand for personal computers will not continue, and the effects of the stock market bubble on asset valuation, investment banking deal flows, and securities trading have already largely evaporated. There are also several gray areas that we cannot judge, including whether consumers will continue to substitute toward higher-value goods at the 1995-99 rate, and what will happen in the portions of the retail and wholesale sectors that we did not study explicitly.

A larger source of uncertainty about future productivity growth is the behavior of the rest of the economy. A review of the historical performance of the other 53 sectors reveals that their average annual productivity growth rates have been quite small over the last two decades. There is, however, natural volatility (i.e., volatility not caused by business cycles) due to changes in industry dynamics and structural changes. If historical precedents hold, this natural volatility could either reduce national productivity growth rates by 0.1 percentage points, or increase them by as much as 0.4 percentage points.

It is possible that other sectors of the economy will defy the historical trend and experience extraordinary productivity jumps. The key criteria for such jumps are the potential for new products, services, or business processes to streamline labor-intensive activities, or to leverage fixed labor costs. Competition is required to diffuse innovation, and regulatory change may be an important triggering mechanism. A quick scan of the economy revealed several sectors with hints of emerging innovators (e.g., software, media/motion pictures, and depository and nondepository institutions) or promising regulatory change (e.g., pharmaceuticals, insurance carriers, and electric, gas, and sanitary services). However, the number of these potential jumping sectors, their relative employment share, and the potential magnitude of their jumps do not appear unusual. Therefore, over the next four years, the impact of labor productivity improvements in sectors such as these should be encompassed largely by the historic productivity volatility in the rest of the economy.

The future of US productivity growth depends on how the uncertainty around all these factors plays out. Our analysis indicates that between 2001 and 2005, the US economy is not likely to revert to pre-1995 productivity growth rates, or exceed 1995-2000 performance (Exhibit 12).[2] The US is also highly unlikely to be facing a decade of economic stagnation like Japan.[3] Unlike Japan and parts of Europe, which are stifled by regulatory restrictions, the US enjoys healthy levels of competition in most economic sectors. This is why it has historically defined the productivity frontier, and will continue to do so.

[2] See pages 12 and 13 of Chapter 3, "Prospective scenarios for US productivity growth," for a full explanation of Exhibit 12.

[3] See the McKinsey Global Institute's report, "Why the Japanese Economy is not Growing: micro barriers to productivity growth," available at www.mckinsey.com. The conclusion of this report is that industry-specific regulatory barriers stifle productivity and investment in 80% of the Japanese economy.

CONFIDENTIAL

Executive Summary

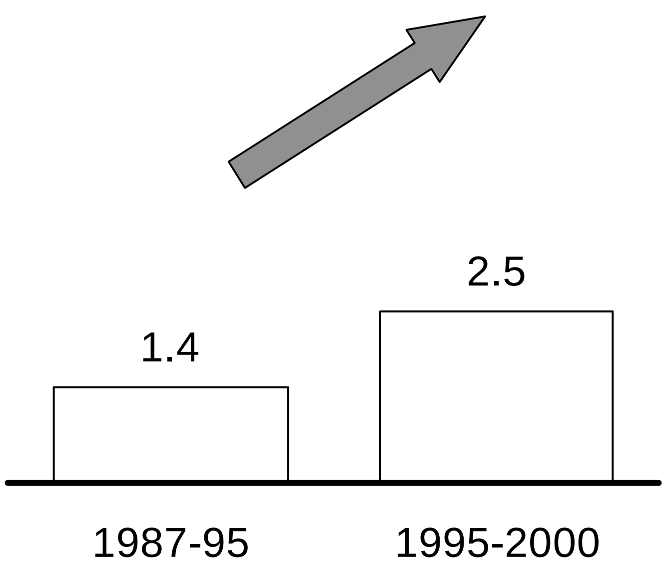
MGI/HIGH TECH PRACTICE NEW ECONOMY STUDY

October 10, 2001

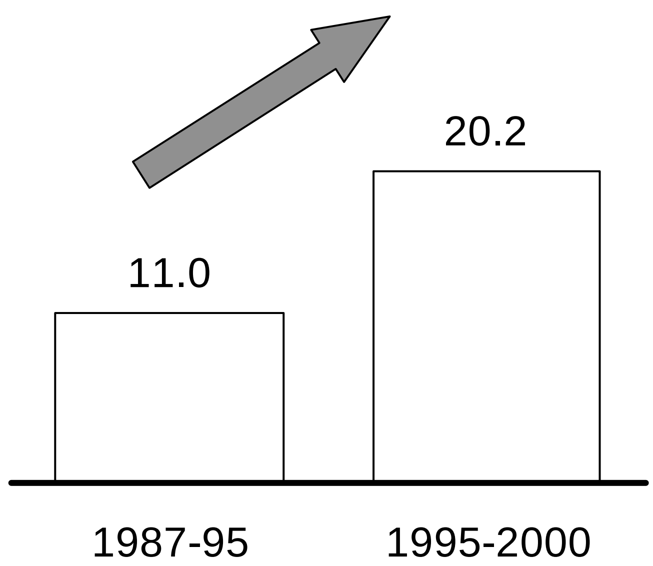
Exhibit 1

A NEW ECONOMY?

Growth in labor productivity*
CAGR, percent



Growth in IT investment
CAGR, percent



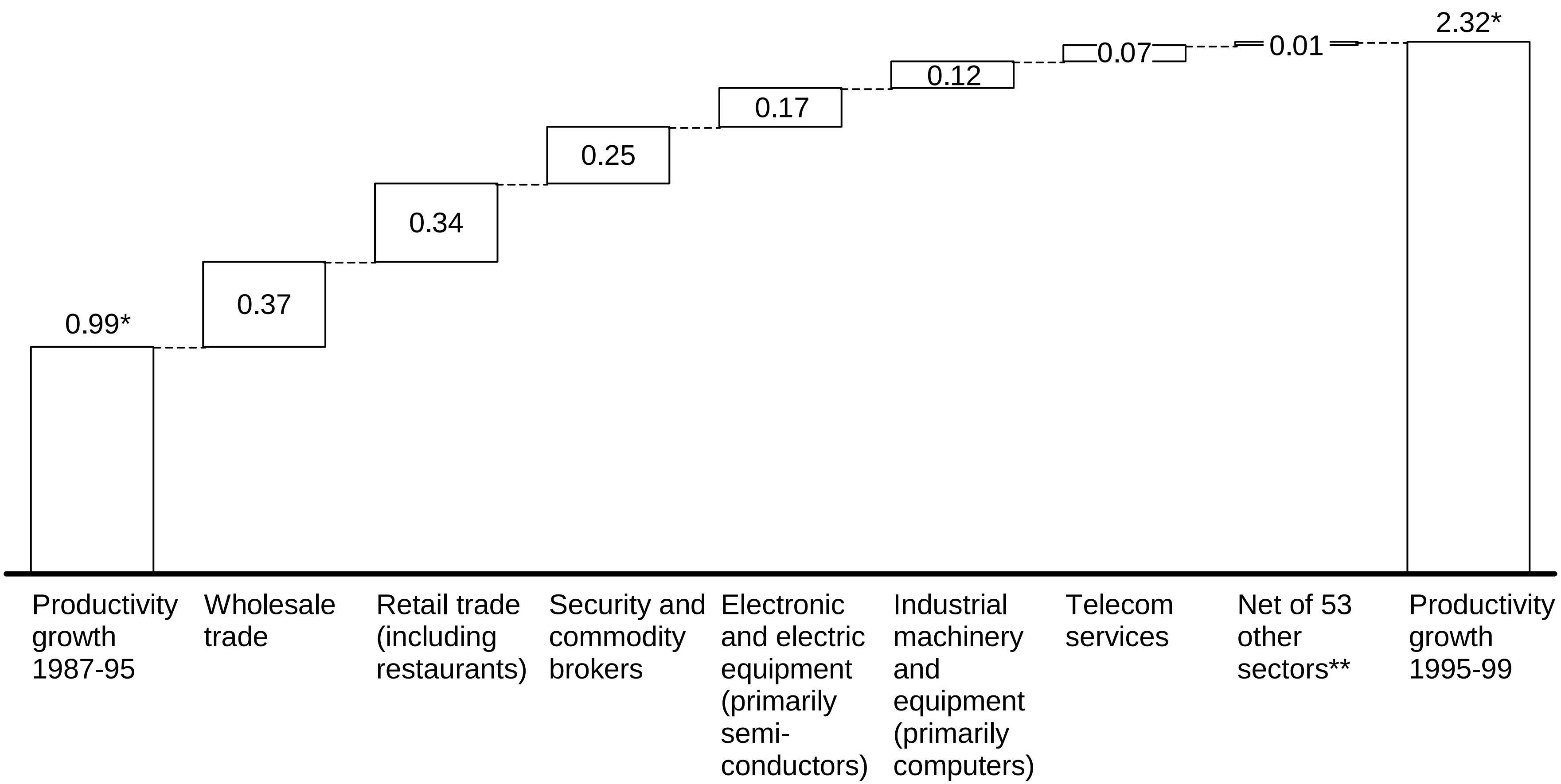
* Excludes output from farms and government; labor productivity is defined here as output per hour worked

Source: BLS; BEA

Exhibit 2

CONTRIBUTION TO 1995 PRODUCTIVITY ACCELERATION

CAGR*, percent



* Industry-level analysis relies upon BEA sector data, which differ slightly from the widely publicized BLS aggregate data shown in Exhibit 1

** 28 sectors made small positive contributions (totaling +0.47) and 25 sectors made small negative contributions (totaling -0.46)

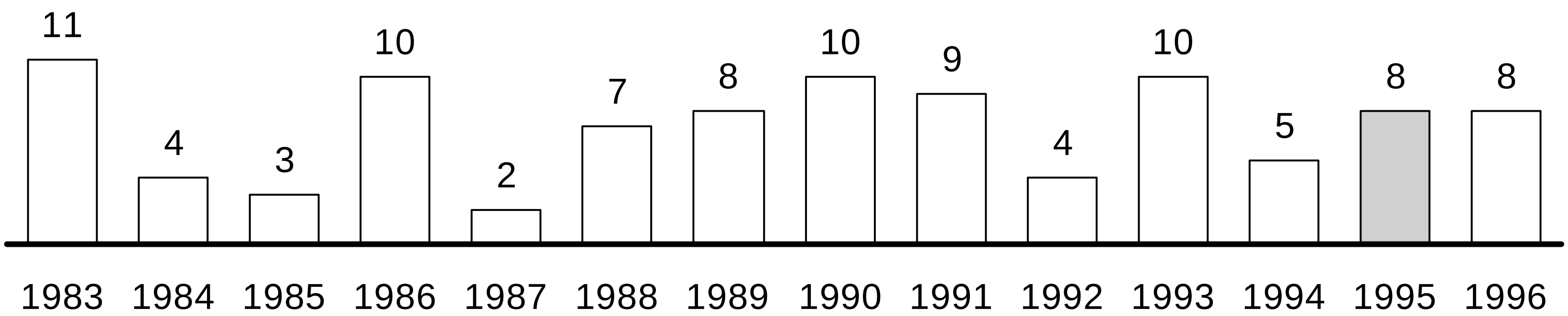
Note: Holdings and other investment offices not classified as a jumping sector because of measurement issues. See appendix of Synthesis chapter and Measurement Appendix for details

Source: BEA; MGI analysis

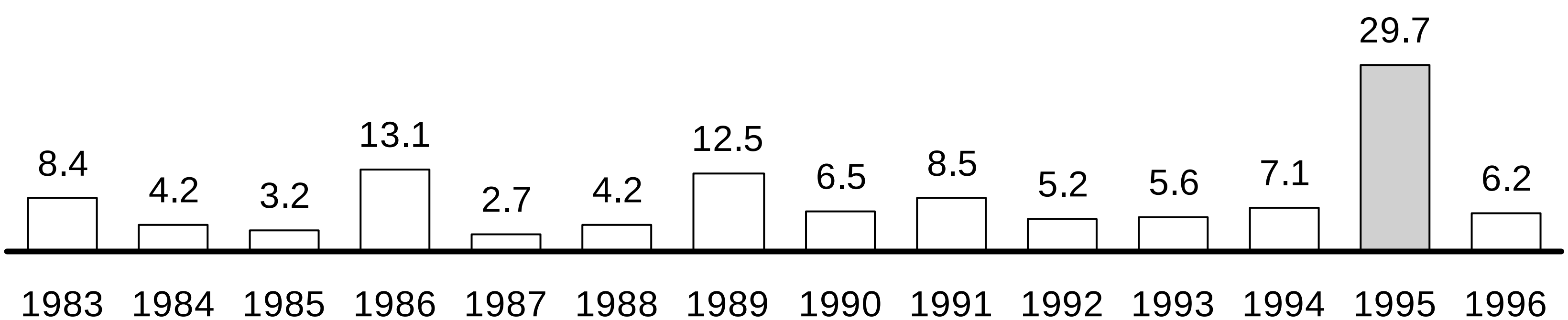
Exhibit 3

EMPLOYMENT IN "JUMPING" SECTORS WAS UNUSUAL IN 1995

Number of jumping sectors*



Share of employment in jumping sectors*
Percent share

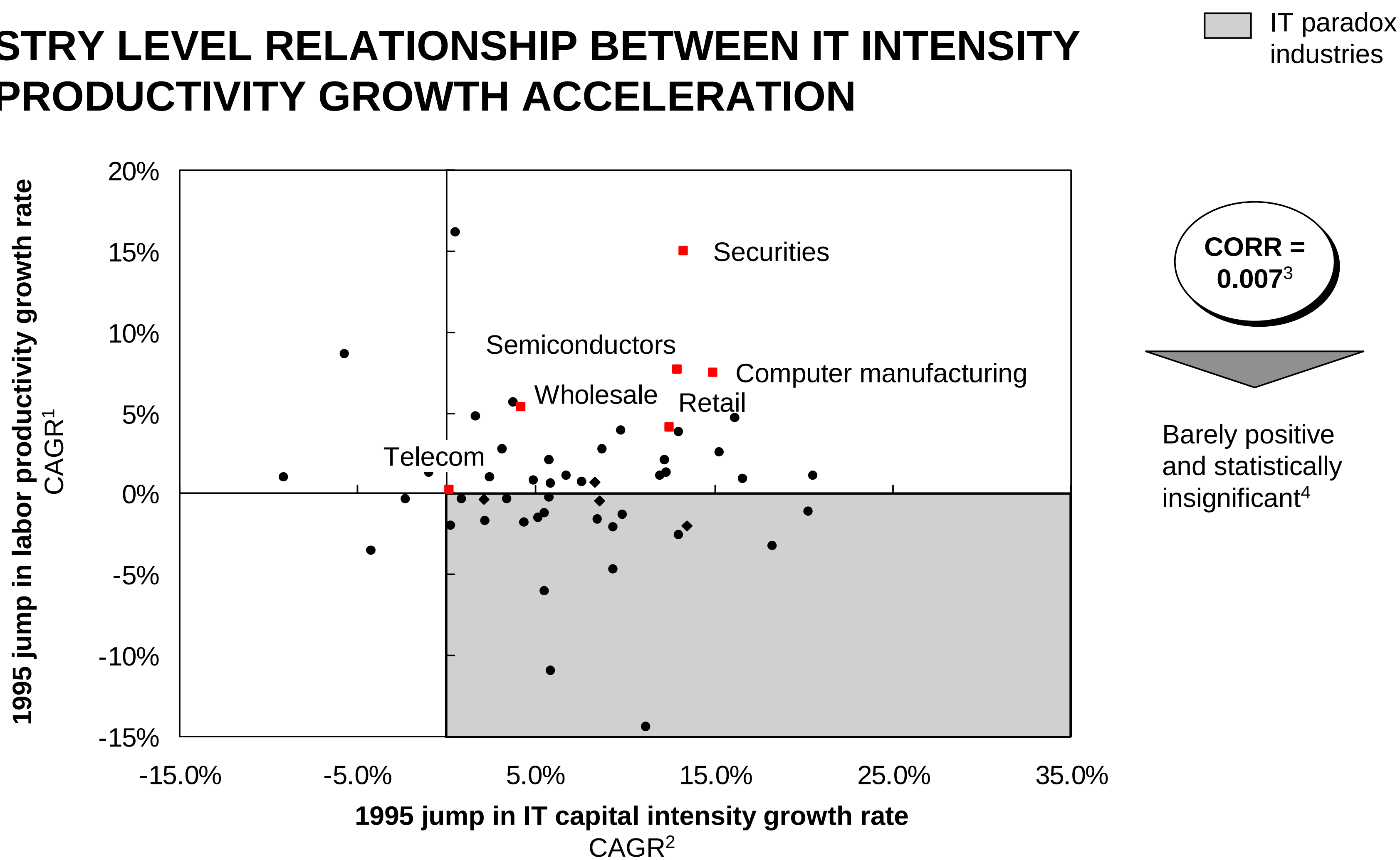


* A sector is classified as "jumping" in year Y if its compounded annual growth rate of productivity for years Y through Y + 3 is at least 3% higher than it was for years Y - 3 to Y

Source: BEA; MGI analysis

Exhibit 4

INDUSTRY LEVEL RELATIONSHIP BETWEEN IT INTENSITY AND PRODUCTIVITY GROWTH ACCELERATION



1 Acceleration in real value added per PEP growth rate between 1987-95 and 1995-99

2 Acceleration in real IT capital stock per PEP growth rate between 1987-95 and 1995-99

3 Excludes farms, coal mining, and metal mining industries due to low initial levels of IT capital stock and holding companies for measurement reasons (see measurement appendix for details)

4 Although weighting each sector by its share of employment yields a statistically significant correlation of 0.26, even the weighted result becomes statistically insignificant if the 6 "jumping" sectors are excluded

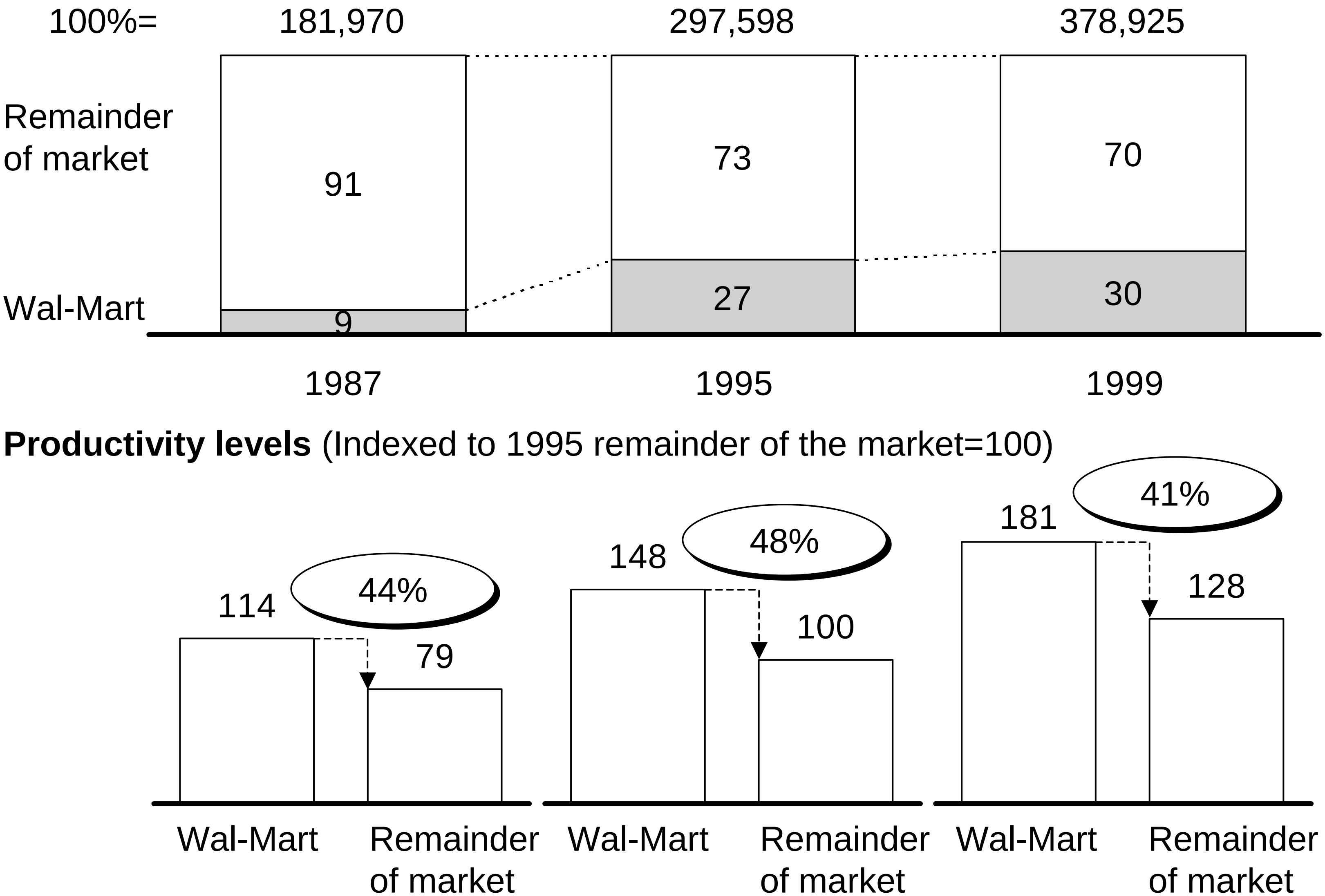
Source: BEA; MGI analysis

Exhibit 5

WAL-MART IS MORE PRODUCTIVE AND IS GAINING SALES SHARE

Sales share (Nominal $ Millions**,** percent)

Productivity levels (Indexed to 1995 remainder of the market=100)

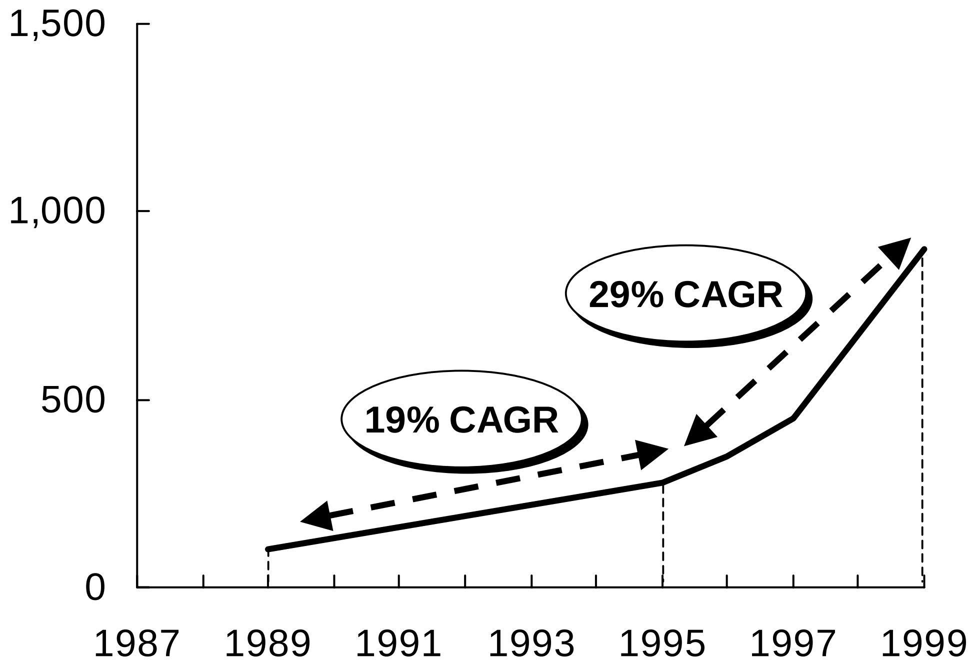


Source: BEA; U.S. Census; 10Ks; annual reports; MGI analysis

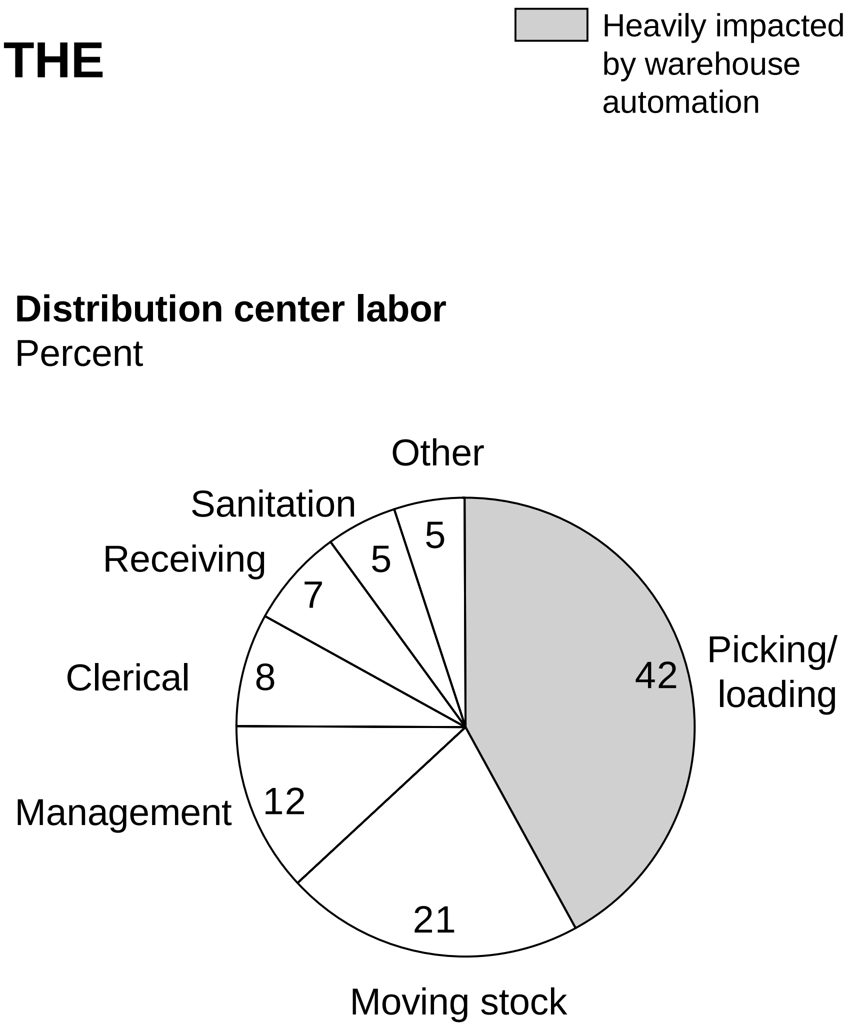
Exhibit 6

WAREHOUSE AUTOMATION REDUCED THE LARGEST LABOR COST CATEGORY

Warehouse management system sales
Nominal $ Millions



Distribution center labor
Percent



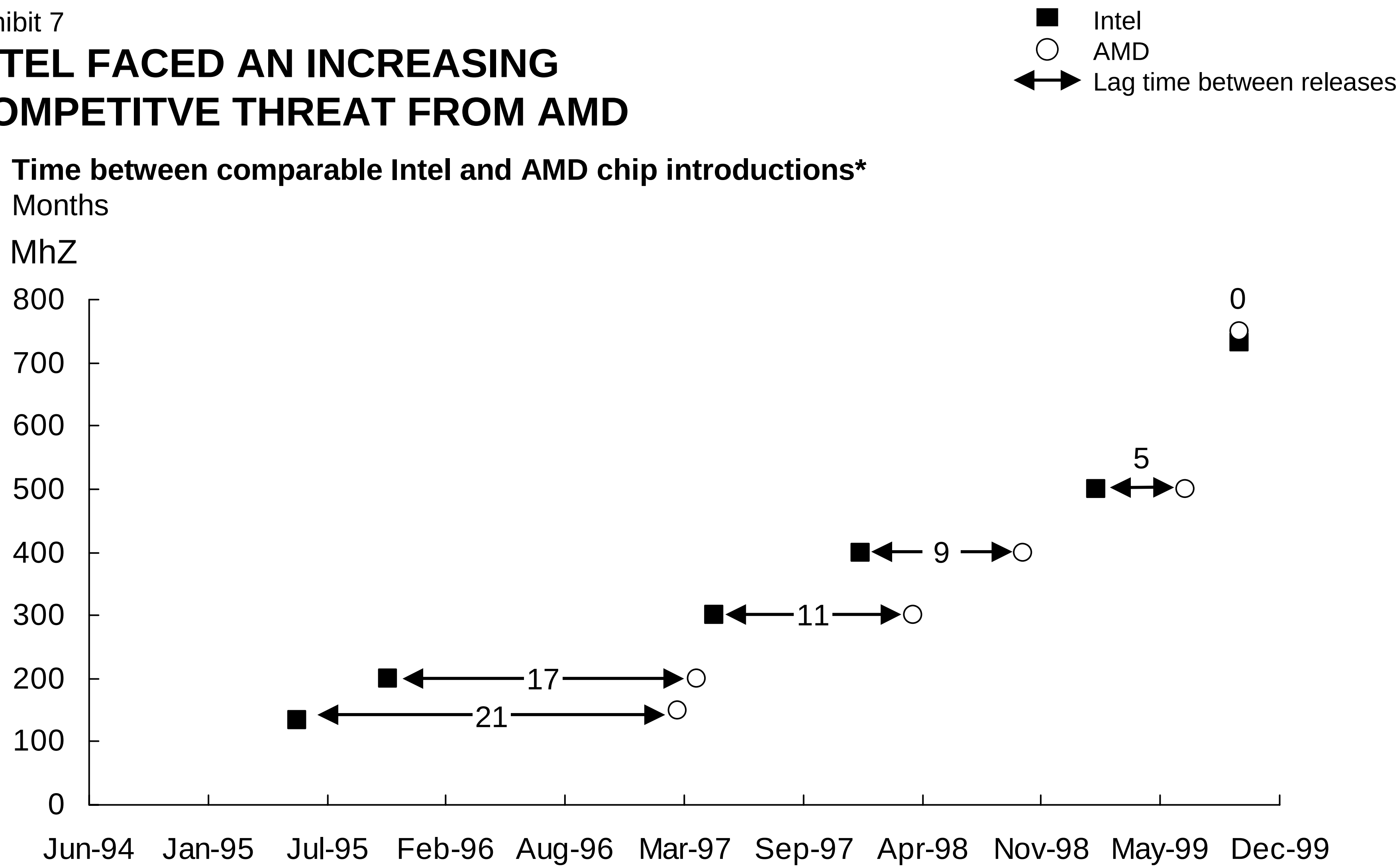
Source: AMR Research, NWDA

Exhibit 7

INTEL FACED AN INCREASING COMPETITVE THREAT FROM AMD

Time between comparable Intel and AMD chip introductions*

Months



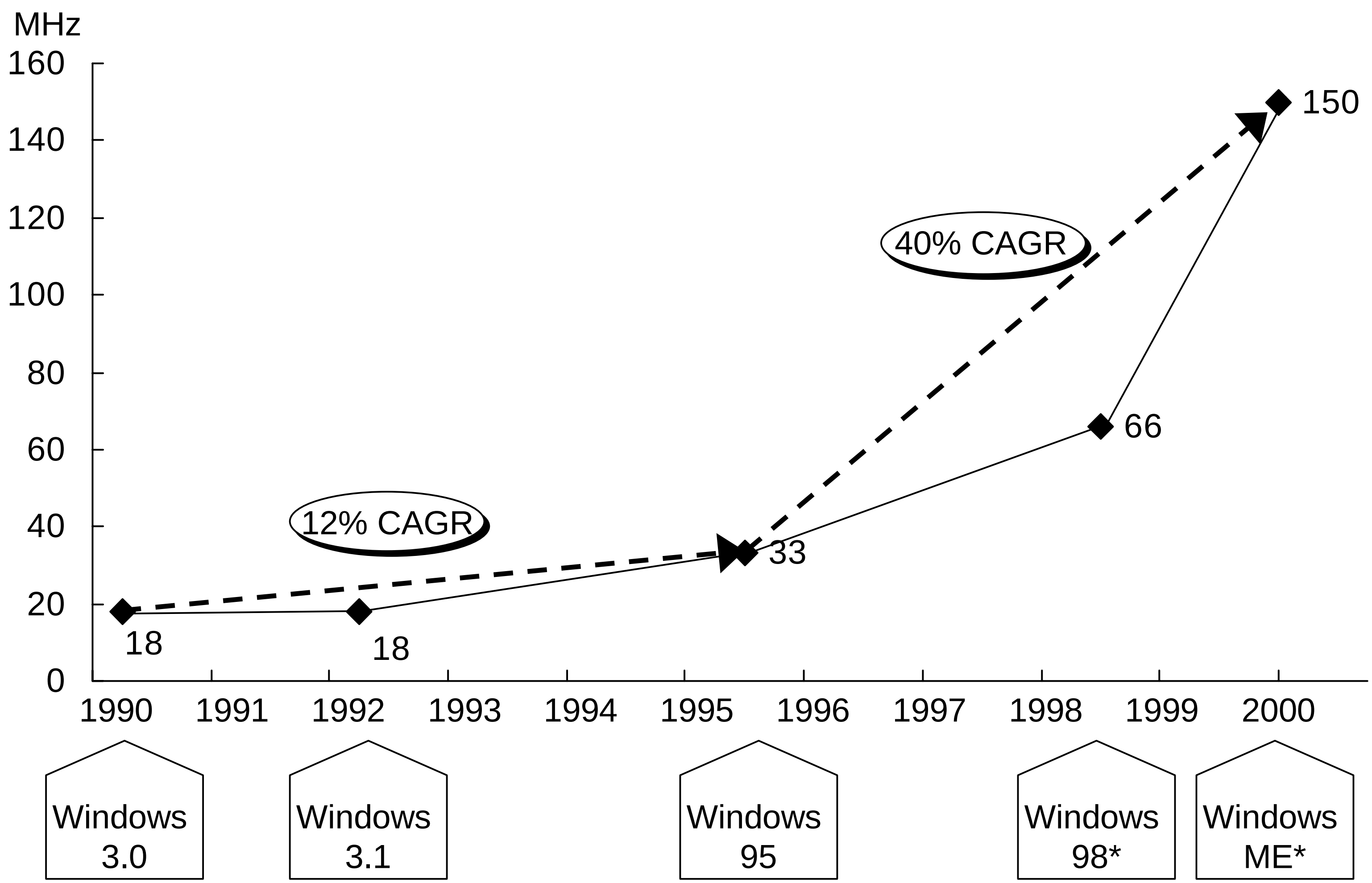
* Only includes releases most suitable to comparison, both companies released many more chips over the period

Source: Intel; Dataquest; Macinfo.de; MGI analysis

Exhibit 8

OPERATING SYSTEMS' PERFORMANCE REQUIREMENTS HAVE ACCELERATED

Processor speed requirement



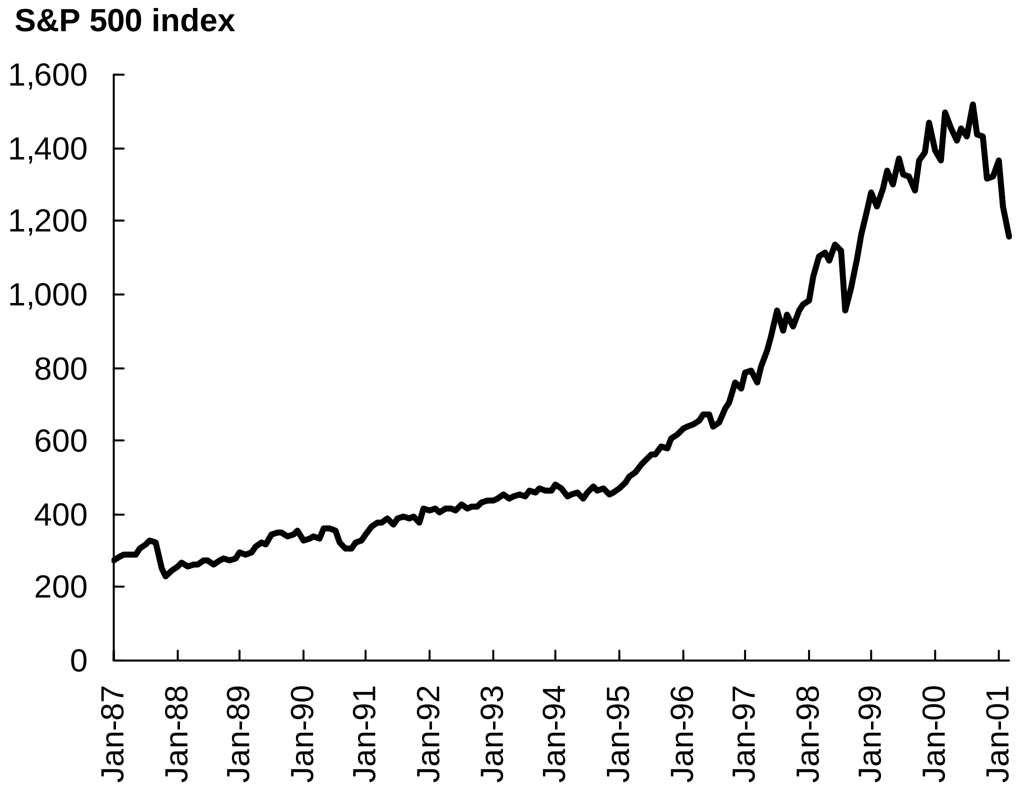
* Second edition

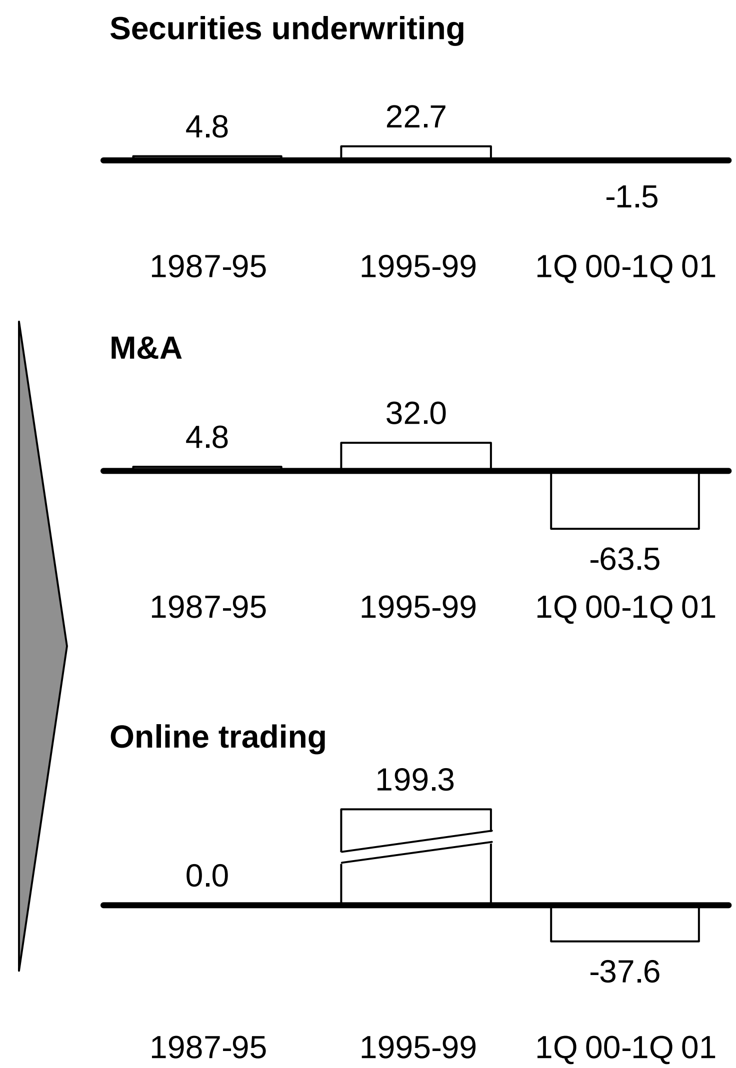
Source: Microsoft; Datapro; McKinsey analysis

Exhibit 9

SECURITIES INDUSTRY OUTPUT IS CLOSELY RELATED TO STOCK MARKET CYCLES

CAGR, percent





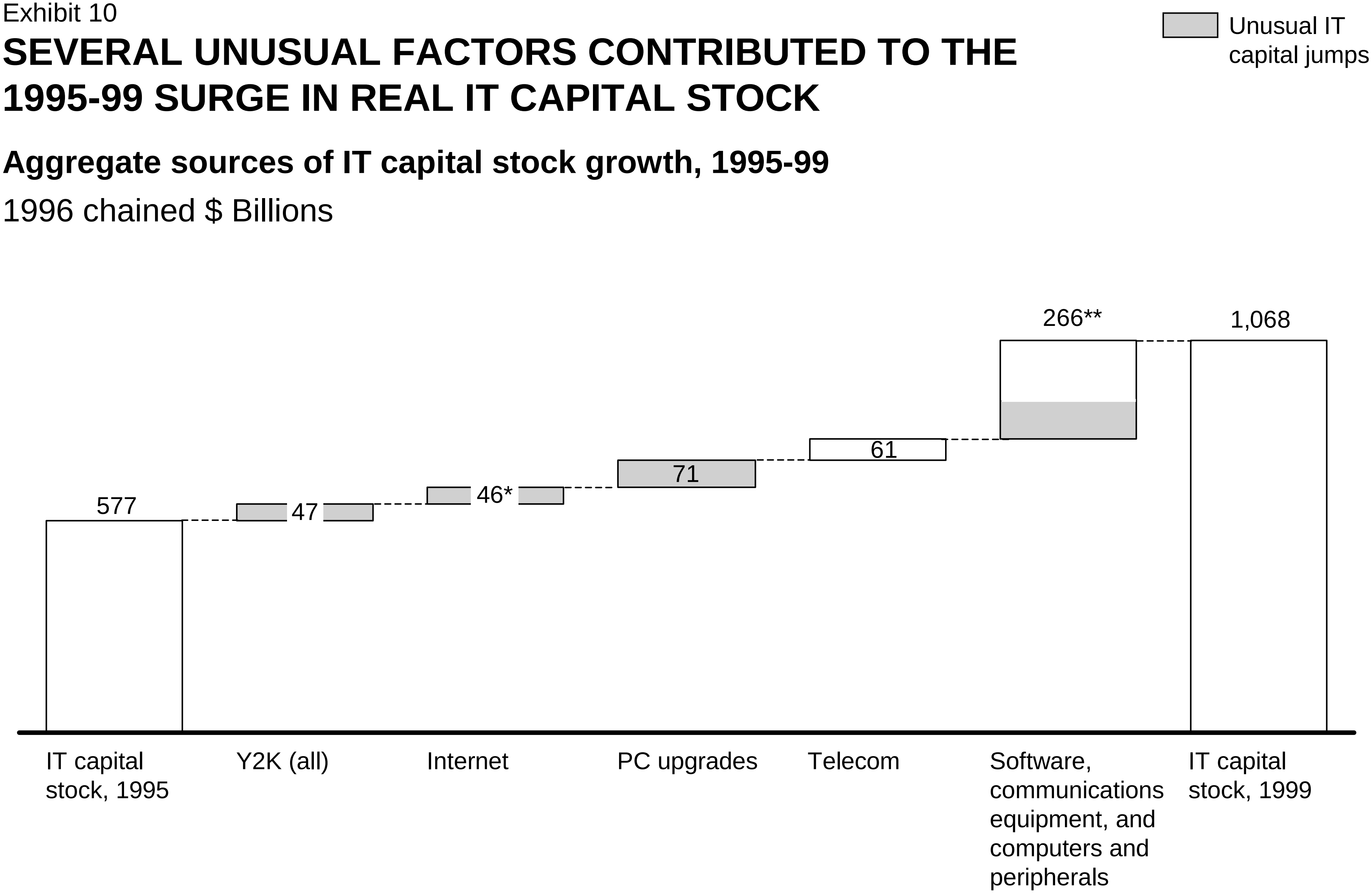
Source: SIA; ICI; SEC; NYSE; NASDAQ; MGI analysis

Exhibit 10

SEVERAL UNUSUAL FACTORS CONTRIBUTED TO THE 1995-99 SURGE IN REAL IT CAPITAL STOCK

Aggregate sources of IT capital stock growth, 1995-99

1996 chained $ Billions



* Excludes 2000, the largest year of Internet investment ($36 billion, nominal)
** Cumulative capital addition and depreciation

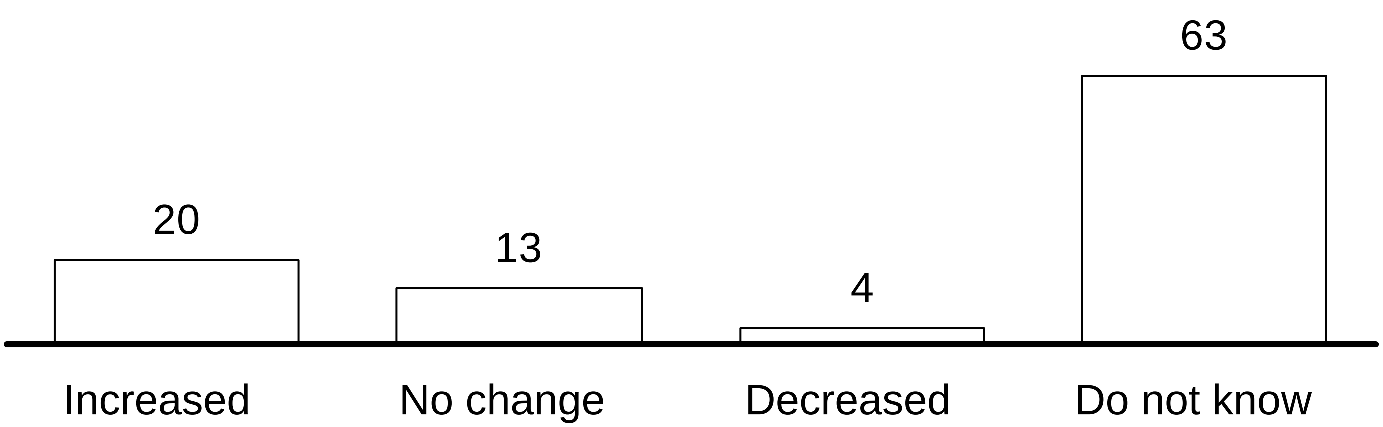
Source: BEA; 10K filings; IDC; Dataquest; Gartner; Rubins; Tower Group; MGI analysis

Exhibit 11

ASSESSMENT OF CRM STRATEGIES

Impact of CRM – change in customer profitability

Percent of surveyed banks



Source: 1999 E&Y Special Report on Technology and Financial Services

Exhibit 12

POTENTIAL SCENARIOS FOR 2001-05 PRODUCTIVITY GROWTH*

CAGR

		6 jumping sectors' performance**	
		Lower bound	Upper bound
Other sectors' performance***	Lower bound	1.6%	2.1%
	Upper bound	2.0%	2.5%

* Comparable to BLS productivity growth rate measure of 1.4% from 1987 to 1995 and 2.5% from 1995 to 2000

** The 6 sectors are wholesale, retail, securities, semiconductors, computer manufacturing, and telecom. The upper bound also captures the potential impact of an unusual jump in another sector. See Prospective Scenarios chapter for details

*** Reflects the historic volatility of productivity performance outside the 6 jumping sectors. See Prospective Scenarios chapter for details

Source: MGI analysis

Objectives and approach

OBJECTIVE OF STUDY

The US has experienced a marked acceleration of economic growth (real output per capita) in the past 5 years (Exhibit 1). The increased rate of economic growth, due in large part to dramatic productivity growth, led many to believe a New Economy had been born. However, the rate of economic growth has now slowed somewhat, and the stock markets are in retreat as consumer and business confidence has dropped. Business leaders are scrambling to reduce costs and production while postponing long-term investment decisions. In the wake, many have been left wondering, what drove the acceleration in US productivity growth in the first place? What role did IT[1] play? How sustainable was it? These are the questions that this report, "US Productivity Growth, 1995-99," seeks to answer.

Understanding productivity growth is critical since it is the key determinant of GDP growth. More efficient use of resources to create value allows the economy to provide lower-cost goods and services relative to the income of domestic consumers, and to compete for customers in international markets. This in turn raises the nation's material living standards. An increase of 1 percentage point in labor productivity growth means GDP per capita will double every 29 years rather than every 50 years.[2] In addition, labor productivity growth is not only a major objective of economic, budgetary, and monetary policy, but also a determinant of economic prospects for companies. The answers to the questions we are addressing have major fiscal implications in terms of tax revenues and surplus. Productivity growth is also a key determinant of higher profitability (see Box 1 in appendix).

GDP per capita is the product of hours worked per capita and labor productivity. Given that employment levels are at record highs, it seems future growth in GDP per capita will have to come from increased labor productivity (Exhibit 1). To understand where the US economy is heading, it is necessary to determine whether the post-1995 labor productivity growth rate is sustainable.

---

1 MGI uses the acronym "IT" to describe information and communications technology. "IT" is intended by MGI to convey the same meaning as the broader term "ITC", which also refers to all information and communications technology.

2 Using the 1987-1995 labor productivity growth rate of 1.4 percent as the starting point and assuming no growth in labor force.

Hence, the two key underlying questions are: First, what caused the jump in labor productivity post-1995, and was this jump due to structural and sustainable factors or cyclical/nonsustainable ones? Second, how much of the structural explanation is due to the dramatic evolution in investments in information technology (IT) over the period under study? Until 1995 this issue was best captured by Robert Solow's statement (the Solow paradox) in 1987, "Computers can be seen everywhere except in the productivity statistics." (Exhibit 2) Has this paradox finally been solved?

This aggregate chapter will proceed as follows: we will review the literature available on this topic and then discuss analysis we have undertaken at the aggregate level. We will then outline the approach we have taken for the remainder of the study. The appendix provides further clarification on a variety of topics discussed in the text of this chapter as well as a glossary of terms used throughout the report and a bibliography of papers referenced. This chapter provides a detailed description of the issues and analytic approach underlying this study. The Synthesis chapter that follows synthesizes the key conclusions that our case studies have generated and also summarizes at a higher level the objectives and approach that guided our research.

STATE OF THE DEBATE

Real output per capita growth rates of almost 4 percent a year have been achieved since 1995 because labor productivity growth nearly doubled and the unemployment rate fell (Exhibit 1). Official data published by the Bureau of Labor Statistics (BLS) from the expenditure side (as opposed to the income side; see appendix for a discussion of the distinction) shows that labor productivity accelerated from 1.4 percent for 1987-95 to 2.4 percent for 1995-99. Putting this in historical context shows that we have returned to approximately the 1947-1972 labor productivity growth rate. However, a review of yearly productivity growth rates (Exhibit 3) puts 1995-99 performance into perspective. Not only does the 1995-99 period not stand out in comparison to the pre-1972 period, but the extreme volatility of these data becomes very apparent.

Aggregate-level analyses by US economists have been inconclusive. The two main topics of contention are: how much of the jump was cyclical vs. structural, and how much of the jump was driven by investments in IT? Although these topics are addressed in order to explain labor productivity, the role of IT is often discussed in the context of multifactor productivity.[3]

---

[3] The difference between labor productivity and multifactor productivity is that the latter controls for the effect of additional investment (see Appendix A for a discussion of the distinction).

Cyclical vs. structural

Different authors argue that anywhere from 30 percent to 100 percent of the post-1995 labor productivity performance is structural, and there are two very extreme camps on the subject of cyclicality. Regarding the latter, one view, espoused most notably by Robert Gordon, finds a strong cyclical component to the labor productivity jump. The other finds little or no evidence of cyclicality. Clearly, the adjustment for cyclicality is a contentious issue, leading many economists to abandon any attempts to make one. To quote Oliner and Sichel, "Separating trend from cycle is always difficult in the midst of an expansion and is particularly hazardous now because the current expansion has not conformed to cyclical norms. In the face of this uncertainty, Gordon imposes a strong assumption that effectively preordains his results."

¶ Robert Gordon is the strongest proponent of a substantial cyclical explanation for the labor productivity growth jump. In his paper titled "Does the New Economy Measure up to the Great Inventions of the Past" he shows that the jump in the non-farm business sector was somewhat evenly split between cyclicality and structural acceleration (Exhibit 4), and the jump in non-durables (consisting mainly of service industries) was almost completely cyclical (Exhibit 5).[4]

¶ In dramatic contrast to Gordon, neither the Economic Report of the President (Exhibit 6) nor Basu, Fernald, and Shapiro[5] find a significant cyclical effect in their analysis despite their attempt to measure one.

The answer to the question of how much of the 1995 productivity growth jump was structural vs. cyclical has major implications for projections of future sustainability of these growth rates. The main source of projections comes from the Congressional Budget Office (CBO), which predicted in August 2001 that labor productivity would continue to grow at a rate of 2.5 percent over the 2001-11 period, implying that all of the 1995-99 growth rate is sustainable.

Productivity growth and IT

One potential source of productivity growth acceleration – which nearly monopolizes discussions of this topic – is increased investment, particularly in IT. There has been a dramatic evolution in IT investment over the period under study (Exhibit 7). More, better, and cheaper IT should, New Economy advocates argue, allow businesses to become much more efficient and to deliver new products and services to consumers.

---

4 This analysis has been updated in Robert Gordon's latest paper titled, "Technology and Economic Performance in the American Economy"

5 Cyclical adjustment by Basu, Fernald, and Shapiro is based on measurement in the labor market.

This question has been addressed using two different frameworks: growth accounting techniques and econometric estimation. No consensus has emerged either within or across these different methodologies with respect to the role of IT in facilitating productivity growth.

Growth accounting techniques

Standard macroeconomic (growth accounting) techniques can be used to decompose labor productivity growth into its causes: capital deepening (increases in capital stock), improvements in labor quality, and increases in total factor productivity (TFP). Almost all the papers discussed above use this methodology to break down the source of the structural growth. As with the attempt to isolate the impact of cyclicality, this work has also yielded a wide range of results. They vary from finding that almost all labor productivity growth is explained by IT, to finding that IT had very little to do with the growth.

¶ Robert Gordon adjusts labor productivity performance by taking out the cyclical effect to isolate the structural acceleration. He then breaks this acceleration down into investment in capital (capital deepening) and TFP. For the breakdown including durables, he finds that structural acceleration is the result of both increased investment in capital and TFP growth in the production of durables (Exhibit 4). For the breakdown excluding durables, he finds a similar contribution of capital deepening (Exhibit 5). However, given the small structural acceleration, this yields a striking result: the application of IT might have contributed to slower TFP growth.

¶ The thinking of the Federal Reserve is largely reflected by the work done by Stephen Oliner and Daniel Sichel. In their paper titled "The Resurgence of Growth in the late 1990s: Is Information Technology the Story?" they attribute none of the jump to cyclicality and instead show that structural labor productivity growth alone explains it (Exhibit 8). They break down this structural growth into approximately 60 percent due to the contribution of TFP growth (half due to the production of IT) and the remainder due to capital deepening (almost completely driven by IT). Their results, therefore, address the Solow paradox by showing that computers have led to a significant jump in productivity growth.

¶ Dale Jorgenson and Kevin Stiroh in their paper titled "Raising the Speed Limit: US Economic Growth in the Information Age" demonstrate similar findings to Oliner and Sichel (Exhibit 9). They also allow no effect for cyclicality and break down structural growth into approximately 55 percent due to TFP growth (only one-third due to IT) and the remainder due to capital deepening (of which only 60 percent is due to IT).

The limitation of the growth accounting technique is that TFP captures a wide variety of factors, including, but not limited to, extra benefits from IT, and that it cannot separate spillovers from IT, since it is based on an implied assumption of historical returns to IT. It cannot say what *actually* happened in terms of capital deepening and multifactor productivity growth.

Econometric estimation

Regression analysis of this topic falls into two camps. The first consists of aggregate-level analysis of the impact of IT, which tends to be very sensitive to assumptions made on functional form and, in addition, can only prove correlation and not causality. The second consists of firm-level analysis, which reveals the complexity with which IT investments impact firm performance.

We discuss aggregate-level analysis of the impact of IT in the context of Stiroh's work. In his paper titled "Information Technology and the U.S. Productivity Revival: What do the Industry Data Say?" he finds a strong link between IT investment and labor productivity gains. However, potential issues with ways to design such analyses as well as the results from our analysis of this question leave things inconclusive.

Stiroh uses gross output data, which does not account for differences in vertical integration / outsourcing over time nor does it take into account differences in the efficiency with which inputs are used (both of which have been influential factors since 1995 - see the section below on sector studies for more discussion).

Stiroh calculates IT intensity in three different ways, including IT share of capital over total capital, which yields the strongest results when he includes all the sectors in his regressions. For this definition he reports that the statistical significance holds even when the IT producing sector and FIRE outliers are dropped. But he does not report the additional results for his other IT intensity definitions.

Stiroh uses an older version of Bureau of Economic Analysis (BEA) IT data that does not include software. Accounting for software in his definition of IT intensity may alter his results.

Using 1995 IT intensity-level data means that Stiroh does not capture the 1995-1999 surge in IT investment in his analysis.

Our MGI findings show that the 1995 jump in the growth rate of IT capital intensity (defined as IT capital per persons employed in production) does not correlate directly with the 1995 productivity growth jump at the industry level (Exhibit 10). However, we do not believe that such high-level correlation can give a definitive answer to the question of the relationship between productivity growth and IT. There are many reasons for our belief, of which five key reasons follow:

1. Correlation does not imply causality.

2. The time lag between changes in IT intensity and changes in productivity growth could affect the correlation's results. We analyzed this factor and determined that adding time lags did not change the results of the correlation. The level and significance of the correlation increased, but the result was still not statistically significant, even with the 3-year lag that yielded the smallest p-value.

3. The relationship between other, non-IT capital and productivity growth could affect the result. MGI controlled for other types of capital and found that doing so did not yield a statistically significant result.

4. The correlation could be sensitive to how the economy is subdivided. We used BEA sector definitions, recognizing that if it were possible to subdivide large sectors such as wholesale and retail, the results of the correlation might be different. A weighted (by employment) correlation, giving larger sectors such as retail more weight in the correlation, yields a positive and significant relationship for all US sectors, but an insignificant correlation outside the six sectors (retail trade, wholesale trade, securities and brokerage, electronics, industrial machinery, and telecom) that contribute the most to the productivity growth jump (see next section for a comprehensive discussion). This finding highlights the need to investigate the actual sources of productivity acceleration in these six sectors.

5. The definition of the productivity measure, which could be based on gross output, value added, or TFP, impacts results significantly.

It is for these reasons that we focus on the incontrovertible finding that productivity growth did not accelerate in many sectors of the economy despite significant increases in IT intensity, rather than on the results of the correlation itself.

Using firm-level analysis, Erik Brynjolfsson and Lorin Hitt find that the combination of computers and organizational co-investments make a substantial contribution to productivity growth. Their analysis clearly reveals that other factors can influence the relationship between IT investments and productivity growth – specifically, complementary investments and organizational and work practices. Their findings contribute to our belief that aggregate-level analysis is not revealing on this topic.

***

Analysis at the aggregate-level of both the role of IT and cyclicality in driving productivity growth have yielded dramatically varying answers. We therefore believe that these issues can only be resolved at the microeconomic level by understanding actual drivers of productivity growth at the industry/sector level.

SECTOR-LEVEL CONTRIBUTIONS TO THE PRODUCTIVITY ACCELERATION

We began our study by pursuing aggregate-level analysis; we broke down the productivity acceleration into the contribution by sector. This breakdown helped to focus our subsequent industry- and firm-level analysis on the key sectors explaining the growth jump.

The data we use from the BEA for our analysis breaks the economy down into 60 sectors (excluding government and farms). Out of these 60 sectors, we found that 38 sectors accounting for 70 percent of aggregate output did experience a productivity jump (Exhibit 11). This analysis also yields two interesting points: many jumping sectors are not IT-producing industries, and many sectors with high-IT-intensity jumps experienced no productivity growth.

Our analysis yields two main findings. First, only six sectors – covering 31 percent of GDP – account for almost all the labor productivity growth jump.[6] Second, although the number of jumping sectors was not unusual, the disproportionate contribution of the six key sectors was possible because two of the sectors were extremely large (retail and wholesale) and two of the jumps were extremely large (semiconductors and computer manufacturing).

¶ Although many sectors of the economy jumped, our breakdown of the labor productivity growth jump[7] into the contribution by industry revealed that 99 percent of the net acceleration in overall US labor productivity growth (and 74 percent of the sum of all positive sectors) can be attributed to only six out of 60 sectors, comprising 28 percent of GDP (Exhibit 11). These six are retail trade, wholesale trade, securities and brokerage, electronics, industrial machinery, and telecom.[8] It is important to note that out of the 0.17 contribution of electronics, 0.20 comes from semiconductors (the remainder of electronics has a -0.03 contribution), and out of the 0.12 contribution of industrial machinery,

---

6 This finding remains true even when the poorly measured sectors (holdings, business services, health services, legal services, education services, social services, membership organizations, other services, private households) are removed from the analysis.

7 Our productivity numbers for each period do not match the BLS numbers for two reasons: first, we use persons employed in production (PEP) as published by the BEA as a labor input instead of hours as published by the BLS; second, we use the BEA industry data, which is calculated from the income side and differs from the expenditure side used by the BLS by the “statistical discrepancy.” Nonetheless, these different data sources yield similar values for the productivity acceleration, 1.0 from the BLS and 1.33 using our methodology.

8 This breakdown excludes the holding sector due to measurement problems. This issue is discussed at length in the measurement section of the report.

0.10 comes from computer manufacturing (refer to relevant case studies for more detail - Exhibit 12). The remaining 53 sectors showed only small positive or negative contributions to jumps. Some additional analysis allowed us to conclude that productivity growth did not accelerate in many other sectors in spite of significant increases in IT intensity.

¶ A historical analysis of the factors that contributed to such a concentrated productivity jump in 1995 is quite revealing. Although 1995 was no exception in terms of the number of sectors that jumped,[9] it was an exception in terms of the size of the sectors and the size of the jumps (Exhibit 13). Some of the sectors that jumped were markedly larger than in the past (retail and wholesale); as such, these six sectors accounted for almost 30 percent of employment in the United States. Some of the jumps were very large (semiconductors and computer manufacturing), reaching 20 percent to 30 percent per year. These factors together explain the dramatic contribution these few sectors made to productivity growth.

Various academics have also addressed the issue of how this dramatic labor productivity growth post-1995 breaks down into specific industry sectors. Nordhaus found, as we did, that productivity growth is concentrated. Although Stiroh did not find this, we believe that had he pushed his analysis one step further his results would complement ours.

¶ In Stiroh's paper titled "Information Technology and the US Productivity Revival: What Do the Industry Data Say?" he finds that the productivity revival is broad-based (Exhibit 14). He makes this claim based on two findings: first, that the mean productivity acceleration is different than zero for all 61 industries and remains so when he removes four outliers (two IT-producing industries plus securities and holdings); second, that two-thirds of the industries show a productivity acceleration. Again, we found that only six sectors accounted for almost all the productivity growth jump. In his analysis, Stiroh identifies and removes four of these six sectors and still finds a significant difference of means. However, had he removed all six sectors, he would have found, as MGI did, that almost all the productivity jump is concentrated in these sectors, which contradicts his result that productivity is broad-based.

¶ Nordhaus in his trilogy of papers analyzing recent productivity behavior (using income-side data from the BEA) corroborates our analysis by finding evidence of "concentrated productivity growth acceleration"

---

9 A sector is classified as "jumping" in year Y if its compounded annual growth rate of productivity for years Y through Y+3 is at least 3 percent higher than it was for years Y-3 to Y.

while also showing that the "productivity rebound is not narrowly focused in a few new economy sectors." His findings reveal that most of the growth came from durable manufacturing, retail, and wholesale trade (Exhibit 15).

APPROACH OF THE STUDY

The approach of our study, as well as the questions we answered, are summarized in Exhibit 16. Findings discussed in this aggregate section led us to pursue in-depth industry studies on two different types of industries (Exhibit 17).

- **Jumping sector cases.** These cases consist of the six sectors that account for the bulk of the productivity growth jump: wholesale, retail, securities, semiconductors, computer manufacturing, and telecom (mobile and long-distance voice). These six sectors account for 31 percent of GDP, 38 percent of the IT-intensity jump, and 31 percent of employment in the US non-farm private sector.
- **Paradox cases.** These cases consist of "paradox" sectors that did not experience productivity growth acceleration despite large IT-intensity increases. Studying these industries serves two purposes: first, they help us develop explanations about why, in some cases, IT intensity jumps did not yield productivity growth jumps; second, they act as a "control" group for our study of jumping sectors. Our two primary paradox cases were retail banking and hotel and lodging places. We also assessed a subsector of telecom (long-distance data) as a paradox case.

In total, our eight in-depth industry studies represent 97 percent of the productivity growth jump, 34 percent of GDP, 42 percent of the IT-intensity jump, and 34 percent of total employment in the US non-farm private sector. The goal of these sector studies is to understand both the past productivity acceleration as well as to predict the sustainability of the 1995-99 growth rate. By looking at common patterns across our industry case studies, we identify the sources of this past growth. Based on these findings we are able to make judgments on the sustainability of these forces for the sectors that we study.

Sector studies

The core of the MGI research project was eight[10] detailed case studies that followed the same sequential analytical process. In each we measured the productivity jump between 1987-95 and 1995-99. We then generated and tested hypotheses on the causal factors that explained the jump. By developing a deep

---

[10] If we include the three telecom sub-cases, this brings our total to ten cases.

microeconomic understanding of industry operations, we were able to draw conclusions on the relative importance of external factors affecting managers' decisions. We then used our analysis to generate estimates of future sustainability of the observed productivity growth rates.

¶ **Measuring productivity.** Productivity reflects the efficiency with which resources are used to create value in the marketplace. It is measured by computing the ratio of output to input. In this study we use labor as an input, thereby focusing on labor productivity as opposed to multifactor productivity (see appendix for a discussion of the two). We first measure productivity by using the gross product origination (GPO) data from the BEA (see appendix for more detail). These data contain value added and persons employed in production (PEP) at the sector level (e.g., retail, wholesale). We chose to use value added for our output measure for three reasons: first, it allowed us to link our case studies with the economy-wide GDP; second, it accounts for differences in vertical integration over time; third, it takes into account differences in the efficiency with which inputs are used. Where we wanted to improve upon the BEA output measure (e.g., in telecommunications) or where we needed a further breakdown of the data for microeconomic causality analysis (e.g., in retail), we went on to gather alternate sources of data from private sector sources for our own estimates of productivity growth. These data sources vary from regulators to industry association data, augmented with interviews with producers.

¶ **Generating and testing causality hypotheses**. To explain why labor productivity growth in the United States jumped, we started by generating a set of hypotheses on the possible causes. The hypotheses were then tested with fact-based analyses. In this phase, we also benefited from McKinsey's expertise in many industries around the world, as well as from the expertise of industry associations and company executives, which allowed us to assess the relative importance of the causal factors in explaining the productivity difference in each sector.

We use a systematic framework to explain productivity differences over time that captures the major possible causal factors. To simplify comparisons across our sectors, we developed two frameworks. The first, applied to the jumping sectors, helps us explain what drove productivity acceleration. The second, applied to paradox cases, explains IT investments that did not drive productivity enhancement. Both frameworks (Appendix: Framework Definition) worked on three levels:

- The firm level, at which productivity changes and IT functionality physically occur and operate

- The industry level, which often drives firm-level performance
- The external level, at which exogenous forces, including but not limited to technology, influence the rules under which industries and firms operate.

¶ **Projecting sustainability.** Armed with a deep understanding of the sources of the productivity acceleration, we then estimated the potential for these high growth rates to continue.

Synthesis

Having identified the causal factors for each industry, we compared the results across industries. The patterns that emerged allowed us to draw conclusions about two topics: the causes of the aggregate productivity jump between 1987-95 and 1995-99, and the role of IT in productivity growth.

APPENDIX A: MEASUREMENT

Labor productivity vs. multifactor productivity

In this study we analyze labor productivity as opposed to multifactor productivity. Labor productivity consists of both contributions from capital deepening as well as multifactor productivity growth (Exhibit A1).

BEA data

The Bureau of Economic Analysis (BEA) provides detailed private industry (62 industries) data at the 2-digit SIC level in their Gross Product Origination (GPO) release. This data contains nominal and chain-weighted gross output (typically "sales") and value-added data (and therefore implicit price deflators) for 1987 to the present and back to 1977 for a select set of industries. Among other things, it also contains employment data in the form of persons engaged in production (a sum of full-time equivalent employees and self-employed).

This GPO data includes a "statistical discrepancy," which reconciles the GPO data with the official GDP and is defined as nominal GDP calculated on the expenditure side less nominal GDP calculated on the income side (gross domestic income or GDI). The BEA views the expenditure side as more reliable.

BLS data

The BLS uses the GDP data (expenditure side) from the BEA and removes the contribution of government, farms, and imputed rents to owner-occupied housing in their public release of US productivity growth. We use the GDP data from the BEA and include rents to owner-occupied housing. These definitional differences explain part of the discrepancy between our breakdown of US productivity growth and the BLS data. Another reason for the discrepancy is that the BLS uses the hours worked data they collect as opposed to the PEP data from the BEA.

Output measurement

For a given industry, the output can be measured in many different ways. The three ways we consider are sales, gross margin, and value added. Sales figures are not net of the value of goods, services, materials, and energy purchased by the industry to produce the final goods or services. Once deflated, sales data corresponds to a "quality-adjusted" physical measure. Gross margin is derived by subtracting COGS from sales, and is not net of the value of services, materials, and energy purchased by the industry to produce the final goods or services. Value added is defined as factory-gate gross margin less purchased services, materials, and energy. The advantage of using value added is that it accounts for differences in vertical integration over time. It also takes into account differences in the efficiency with which inputs are used. However, it is not always readily available at the level of industry disaggregation we require for our industry analyses.

GDP can be seen as a value-added concept of output. In nominal terms, GDP is the market value of final goods and services produced by means of the labor and capital services available within the country.

In the case studies for computer manufacturing and semiconductors we used the value-added measure of output. In all our case studies, we use a physical measure of productivity.

Labor input measurement

As discussed above, for labor input measurement we start by using the BEA measure of persons engaged in production (PEP). This measure adjusts for hours worked by first calculating full-time equivalents and then adds on data measuring the self-employed. This data is not completely equivalent to the BLS total hours data and, therefore, as mentioned above, contributes to the difference in the BLS's and our measurements of US productivity growth. At the sector level for some cases, the labor input data we require is quite granular and only available in the form of hours from the BLS.

Contribution analysis

The first step of the sector contribution analysis was to separate out mathematically output and employment growth from productivity growth (Exhibits A2 and A3). Then, taking into account the non-additivity of real numbers in calculating sector contributions, we use the latest GDP growth contribution formula developed by Yuri Dikanov from the World Bank, which is described in the October 1999 *Survey of Current Business* (Exhibit A4; see the article, "A Preview of the 1999 Comprehensive Revision of the National Income and Product Accounts: Statistical Changes" by Brent R. Moulton and Eugene P. Seskin).

We can isolate the "within" effect by assuming that the share of employment is fixed. By residual, we can calculate the "mix-shift" effect for each sector.

A sector can contribute to the aggregate productivity growth in two ways: "within" effect and sector "mix" effect. A sector's within effect depends solely on productivity growth within that sector whereas its mix effect depends on both its relative employment growth and its relative productivity level. For example, the semiconductor industry contributes to the aggregate productivity growth by yielding a large productivity growth within the sector and through the mix effect, since it is five times more productive relative to the rest of the economy and its employment share is also increasing.

We have found our contribution analysis method conceptually consistent with methods used by Stiroh and Nordhaus (Exhibit A5). We also find that our method yields similar numbers as reported by Stiroh and Nordhaus.

Deflators/indexes

Deflators or price indexes are used to convert nominal numbers to quality-adjusted output measures. A price index should measure the change in the cost of purchasing a fixed basket of goods and services over time. However, a complication arises as consumers substitute away from goods and services whose prices rise the most rapidly and toward those goods and services whose prices rise less rapidly or decline. A fixed-weight price index such as a Laspeyres or Paasche does not adjust for this substitution. A Laspeyres index uses a fixed basket from the starting period and, therefore, gives too much weight to the prices that rise rapidly over the time span and too little weight to the prices that fall, thereby overstating the price increase. A Paasche index uses a fixed basket from the ending period and therefore results in the exact opposite effect. Superlative indexes such as Fisher and Tornqvist adjust for this substitution bias.

APPENDIX B: FRAMEWORKS

As discussed earlier, to simplify comparisons across our sectors, we developed two frameworks. The first, applied to the jumping sectors, helped us explain what drove productivity acceleration (Exhibit A6). The second, applied to paradox cases, explained IT investments that did not drive productivity enhancement (Exhibit A7). Both frameworks are now described in turn.

Jumping sector cases

Firm level. The first set of factors affecting productivity arises at the firm level. Firm-level factors in the framework are jointly determined by elements of a firm's external environment beyond its control and decisions made by its managers.

- **Output mix**. The mix of products demanded or supplied over time may differ and a productivity advantage or penalty can arise if output consists of a higher share of inherently more or less productive product or service categories (due, for example, to design changes that simplify the production process and improve productivity). Within product categories, the quality of the product produced may also differ. Production of higher-value-added products or services using similar levels of inputs is reflected in higher productivity. Another source of productivity differences within product categories is differences in product range. A wider range of product or service lines can reflect a suboptimal product mix that reduces productivity.

- **Capital/technology/capacity.** We use capital in the sense of physical assets and their embodied processes (e.g., machines, plants, buildings, and hardware). Capital can influence labor productivity in two ways. First, if an industry works with a higher capital intensity, i.e., uses more capital in combination with each unit of labor, we expect that this industry would show higher labor productivity. Second, a more technologically advanced stock of capital should also enhance labor productivity.

- **Intermediate inputs/technology.** Higher value/quality inputs (including embedded technology).

- **Labor skills.** This refers to the current and potential skill exhibited in the pool of labor from which a company chooses employees. Firms can either train employees from scratch, which takes time, or employ ready-trained workers.

- **Labor economies of scale.** Leverage of fixed labor.

- ¶ **Organization of functions and tasks/process (OFT) design.** This is a broad category encompassing the way in which production processes and other key functions (product development, sales, marketing) are organized and run. It reflects managerial practices in most areas of the business system, as well as the structure of incentive systems that employees and companies face.

Industry level. The competitive pressure in the industry influences the pressure on management to adopt best practices in the production process. We include two types of factors: competitive intensity and price/demand effects.

- ¶ **Competitive intensity.** This reflects differences in the industry structure and the resulting competitive behavior of domestic players. Other factors being equal, more competitive industries will put more pressure on managers to adopt more productive processes.
- ¶ **Price/demand effects.** Endogenous changes in prices and/or demand.

External level. These factors are mainly outside the control of firms but influence how they operate.

- ¶ **Demand factors.** Macroeconomic/financial markets, consumer preferences, etc.
- ¶ **Technology/innovation.** Technological or managerial innovation in own or related industry.
- ¶ **Product market regulation.** Regulations prohibiting or discouraging certain products or service offerings (including regulations on pricing) can reduce or eliminate high-productivity production. Product-market regulations can also limit or distort competition by protecting or favoring incumbent companies.
- ¶ **Up- /downstream industries.** Upstream suppliers or downstream industries can affect productivity by reducing or increasing competitive pressures on industry players. An underdeveloped upstream industry can also impose significant productivity costs on its clients by not providing products or services that facilitate production or by delivering outputs with lower quality and/or at high fluctuations.
- ¶ **Measurement issues.** Measurement issues causing a measured jump.

Paradox cases

Firm level. The first set of factors affecting productivity arises at the firm level. Firm-level factors in the framework are jointly determined by elements of a firm's external environment beyond its control and decisions made by its managers.

- ¶ **Unmeasured convenience to consumers/surplus shift.** IT-intensity surge that increased consumer surplus or shifted surplus between producers but did not increase aggregate productivity.
- ¶ **Y2K compliance.** IT-intensity surge was required to avoid systems failure but did not increase productivity.
- ¶ **Software and hardware that did not yield expected returns.** IT-intensity surge failed to increase productivity because some portion of investment, to date, has not lived up to expectations.
- ¶ **Excessive/unnecessary investment.** IT-intensity surge failed to increase productivity because all signs point to some portion of investment having been wasted, with low probability of future payoff.

Industry level. The competitive pressure in the industry influences the pressure on management to adopt best practices in the production process. We include two types of factors: competitive intensity, and price/demand effects.

- ¶ **Low competitive intensity.** Imperfect competition in some segments of the industry.
- ¶ **Lower-than-expected demand.** Incorrect industry beliefs about the future trajectory of demand for specific goods or services.

External level. These factors are mainly outside the control of firms but influence how they operate.

- ¶ **Demand factors.** Macroeconomic/financial markets.
- ¶ **Product-market regulation.** Regulations prohibiting or discouraging certain products or service offerings (including regulations on pricing) can reduce or eliminate high-productivity production. Product-market regulations can also limit or distort competition by protecting or favoring incumbent companies.
- ¶ **Y2K.** The existence of systems whose utility would have expired on January 1, 2000, because of two-digit date codes.
- ¶ **Unmeasured consumer benefits.** The difficulty of measuring all benefits received by consumers from certain IT investments/functionality.

Box 1

PRODUCTIVITY AND PROFITABILITY

Within any given market, a firm that is more productive will enjoy higher profitability, unless it suffers from some other source of cost disadvantage. A more productive firm will either produce the same output with fewer inputs and thus enjoy a cost-advantage, or produce better output with the same inputs and thus enjoy a price-premium.

Over time, the higher profitability of productive firms will attract competition. As competitors catch up in productivity, profitability will tend to converge. In such an environment, the only way a firm can enjoy higher profitability is by pushing the productivity frontier beyond its competitors. If, as a result, the firm achieves higher productivity, it will enjoy higher profitability only until its competitors catch up again. In another words, profitability, in a dynamic world, is a transient reward for productivity improvements.

While a more productive firm will enjoy higher profitability within a given market, this may not be true for firms operating in different markets, for two reasons. First, higher cost of inputs may deem a productive firm in one market unprofitable, while a less productive firm in another market with lower cost of inputs may be profitable. For example, a US firm may be more productive but less profitable than a Japanese firm because US wages are higher. Second, competitive intensity may differ across markets so that a productive firm in a highly competitive market may be less profitable than an unproductive monopolist or oligopolist in another market. For example, in the 1980s European airlines enjoyed higher profitability than their more productive US counterparts because they faced much less price competition.

However, deregulation and globalization are eliminating distinctions between national markets. As barriers are removed, productive firms will enter markets with unproductive incumbents. This could take the form of exports if the goods are traded. While cheap input prices may temporarily shield unproductive incumbents in the importing country, those input price differences are not sustainable in the long run. The cost of capital (a key input price) is converging internationally, and wages (the other key input price) will eventually catch up with productivity (so that no country can enjoy both low wages and high productivity in the long run). The other form of market entry for productive firms is foreign direct investments. In this case, productive transplants will face the same input prices as unproductive incumbents, and will therefore enjoy higher profitability.

In sum, as markets liberalize and globalize, the only sustainable source of higher profitability for a firm will be to continually raise productivity higher than its competitors.

BIBLIOGRAPHY

Baily, Martin and Lawrence, Robert Z. (2000) *Do We Have a New E-conomy?* NBER Working Paper #8243.

Bassanini, Anrea and Scarpetta, Stefano, and Visco, Ignazio. (2000) *Knowledge, Technology, and Economic Growth: Recent Evidence from OECD Countries.* OECD Working Paper #259.

Basu, Susanto, John Fernald and Matthew Shapiro. (2000) *Productivity growth in the 1990s: Technology, Utilization, or Adjustment?* Presented at the Carnegie-Rochester conference, November 2000.

Blinder, Alan S. (2000) *The Internet and the New Economy.* Brookings Policy Brief #60.

Boskin Commission. (1996) *Toward A More Accurate Measure of the Cost of Living.*

Bosworth, Barry and Triplett, Jack. (2000) *What's New about the New Economy? IT, Economic Growth and Productivity.* Brookings Working Paper.

Bresnahan, Timothy F and Brynjolfsson, Erik and Hitt, Lorin M. (1999) *Information technology, Workplace Organization, and the Demand for Skilled Labor: Firm-level Evidence.* NBER Working Paper #7136.

Brynjolfsson Erik and Hitt, Lorin M. (2000) *Computing Productivity: Firm-Level Evidence.* Working Paper.

Brynjolfsson, Erik and Hitt, Lorin M. *Paradox Lost? Firm-level Evidence of High Returns to Information Systems Spending.* Management Science. April 42:4, pp. 541-58.

Brynjolfsson, Erik and Hitt, Lorin M. (1998) *Beyond the Productivity Paradox.* Communications of the ACM.

Brynjolfsson, Erik and Hitt, Lorin M. *Beyond Computation: Information Technology, Organizational Transformation and Business Practices.* Journal of Economic Perspectives, Vol. 14, No. 4, pp. 23-48.

Department of Commerce, Bureau of Economic Analysis (1999). *Fixed Reproducible Tangible Wealth in the United States, 1925-94.* Government Printing Office.

Department of Commerce, Bureau of the Census (2000). *Digital Economy 2000.* Government Printing Office.

Council of Economic Advisors. (2000) *Economic Report of the President.* Washington, DC., US Government Printing Office.

Council of Economic Advisors. (2001) *Economic Report of the President.* Washington, DC., US Government Printing Office.

Goldman Sachs. (2000) *Productivity and the Digital Revolution.* Global Economic Weekly, Issue No: 00/23.

Goldman Sachs. (2000) *The Digital Revolution Outside the United States.* Global Economic Weekly, Issue No: 00/27.

Goldman Sachs. (2000) *The Case Against the IT Miracle.* Global Economic Weekly, Issue No: 00/28.

Gordon, Robert. (2000) *Has the "New Economy" Rendered the Productivity Slowdown Obsolete?* Unpublished working paper, Northwestern University, September.

Gordon, Robert. (2000) *Interpreting the 'One Big Wage' in US Long-term Productivity Growth,"* in Bart van Ark, Simon Kuipers, and Gerard Kuper, eds., Productivity, Technology, and Economic Growth, Kluwer Publishers, pp. 19-65.

Gordon, Robert. (1999) *The Boskin Commission Report and Its Aftermath.* NBER Working Paper #7759.

Gordon, Robert (2000) *Does the "New Economy" Measure up to the Great Inventions of the Past?* Journal of Economic Perspectives, vol. 14 (Fall), pp. 49-74.

Greenlees, John S. and Mason, Charles C. (1996) *Overview of the 1998 Revision of the Consumer Price Index.* Monthly Labor Review, Vol. 119, No. 12, Bureau of Labor Statistics.

Greenspan, Alan. (2000) *Technology Innovation and its Economic Impact.* Remarks before the National Technology Forum, St. Louis, Missouri.

Greenspan, Alan. (2000) *Structural Change in the New Economy.* Remarks before the National Governors' Association, 92nd Annual Meeting, State College, Pennsylvania.

Holdway, Michael *Quality-Adjusting Computer Prices in the Producer Price Index: An Overview.* Bureau of Labor Statistics.

Jorgenson, Dale and Stiroh, Kevin. (1999) *Information Technology and Growth.* American Economic Review, Papers and Proceedings, 89(2), pp. 109-115.

Jorgenson, Dale and Stiroh, Kevin. (2000) *Raising the Speed Limit: US Economic Growth in the Information Age.* Brookings Papers on Economic Activity, 31:1, pp. 125-211.

Krugman, Paul (1997) *Speed Trap: The Fuzzy Logic of the "New Economy"*

Krugman, Paul (1997) *How Fast Can the US Economy Grow?* Harvard Business Review, July.

Landefeld, J. Steven and Fraumeni, Barbara. (2000) *Measuring the New Economy.* Presented at the May 5 meeting of the BEA Advisory Committee.

Landefeld, J. Steven and Grimm, Bruce T. (2000) *A Note on the Impact of Hedonics and Computers on Real GDP.* Presented at the November 17 meeting of the BEA Advisory Committee.

Litan, Robert and Alice Rivlin. (2001) *Project the Economic Impact of the Internet.* American Economic Review, May 2001 (Papers and proceedings), 91(2).

Lum, Sherlene K.S, Moyer, Brian C. and Yuskavage, Robert E. (2000) *Improved Estimates of Gross Product by Industry for 1947-98.* Survey of Current Business, June.

Lum, Sherlene K.S., and Moyer, Brian C. (2000) *Gross Domestic Product by Industry for 1997-99.* Survey of Current Business, vol. 80, no. 12, December, pp. 24-35.

Oliner, Stephen and Sichel, Daniel. (2000) *The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?* Journal of Economic Perspectives, vol. 14, Fall, pp. 3-22.

Mack, Connie (1999) *The Growth and Prosperity Series: Economic Growth and the Future Prospects of the US Economy*

Nordhaus, William. (2001) *New Data and Output Concepts for Understanding Productivity Trends.* NBER Working Paper #8097.

Nordhaus, William. (2001) *Alternative Methods for Measuring Productivity Growth.* NBER Working Paper #8095.

Nordhaus, William. (2001) *Productivity Growth and the New Economy.* NBER Working Paper #8096.

Organization of Economic Development. (2000) *A New Economy? The Changing Role of Innovation and Information Technology in Growth,* Paris.

Sharpe, Andrew and Leila Gharani. (2000) *The Productivity Renaissance in the US Service Sector.* International Productivity Monitor, Center for Living Standards, Ottawa, Canada, pp. 6-8.

Sinclair, James and Catron, Brian (1990) *An Experimental Price Index for the Computer Industry.* Monthly Labor Review, Vol. 113, No.10.

Solow, Robert (1957) *Technological Change and the Aggregate Production Function*, Review of Economics and Statistics, August, 39:3, pp. 65-94.

Stiroh, Kevin. (2001) *Information Technology and the US Productivity Revival : What to the Industry Data Say?* Federal Reserve Bank of New York Staff Report #115.

Triplett, Jack. *High-tech Industry Productivity and Hedonics Price Indices.* OECD Proceeding: Industry Productivity, International Comparisons and Measurement Issues, pp. 119-142.

Triplett, Jack. (1999) *The Solow Productivity Paradox: What Do Computers Do to Productivity?* Canadian Journal of Economics, 32:2, April, pp. 309-34.

Triplett, Jack and Bosworth, Barry (2000). *Productivity in the Service Sector.*

Triplett, Jack. (1999) *Economic Statistics, the New Economy and the Productivity Slowdown.* Business Economics, XXXIV(2), pp. 13-17.

Venkatraman, N. (1994) *Enabled Business Transformation: From Automation to Business Scope Redefinition.* Sloan Management Review, pp. 73-87.

Whelan, Karl. (2000) *Computers, Obsolescence, and Productivity.* FEDS working paper.

Yuskavage, Robert E. (2000) *Priorities for Industry Accounts at BEA.* Presented at the November 17 meeting of the BEA Advisory Committee.

CONFIDENTIAL

Aggregate

MGI/HIGH TECH PRACTICE NEW ECONOMY STUDY

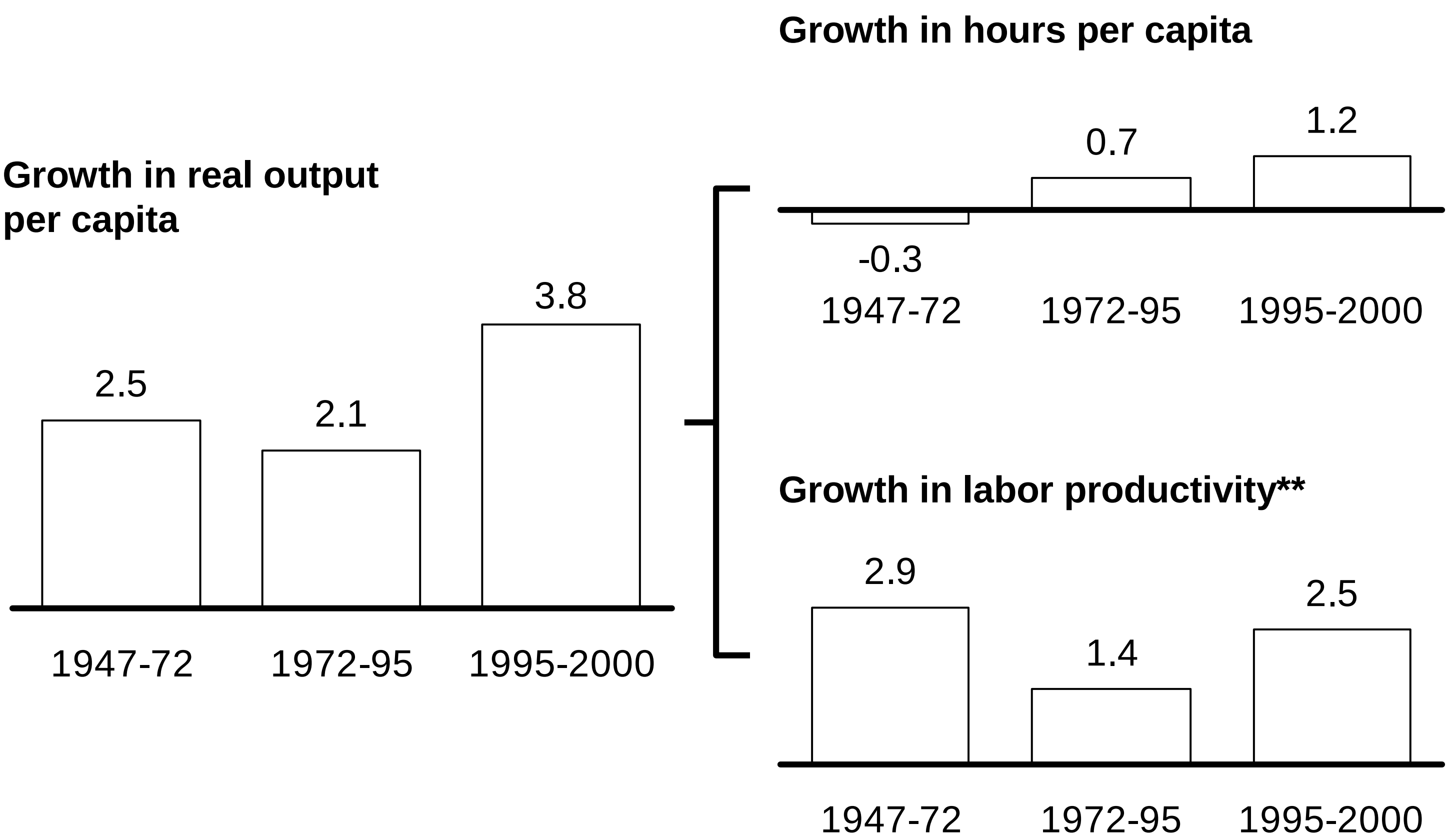
Write up

September 10, 2001

Exhibit 1

OUTPUT PER CAPITA GROWTH OF NON-FARM BUSINESS*

CAGR, percent



* Excludes output of farms and government

** Labor productivity is defined here as output per hour worked

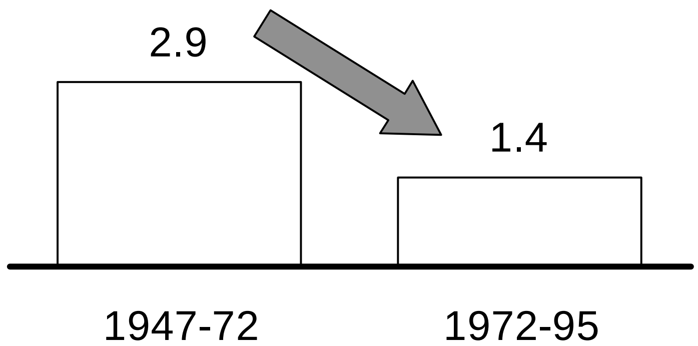
Source: BLS

Exhibit 2

THE SOLOW PARADOX

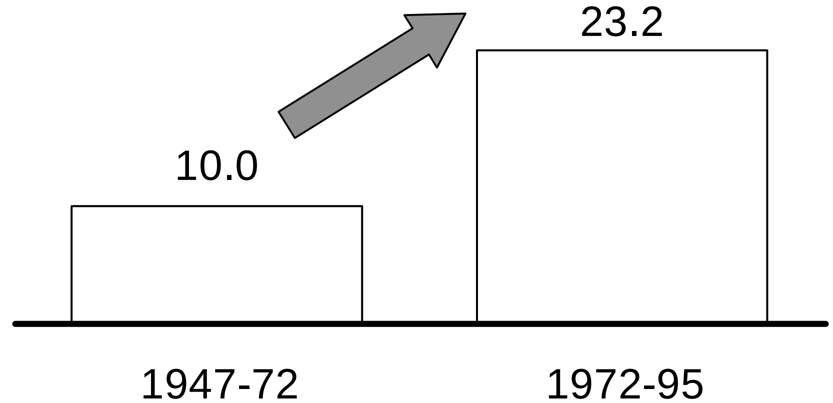
CAGR, percent

Growth in labor productivity*



IT investment as percent of total business investment**

Average percent share



"You can see the computer age everywhere but in the productivity statistics"

Robert Solow, 1987

* BLS non-farm labor productivity

** BEA NIPA information processing equipment and software as a percentage of total nonresidential investment

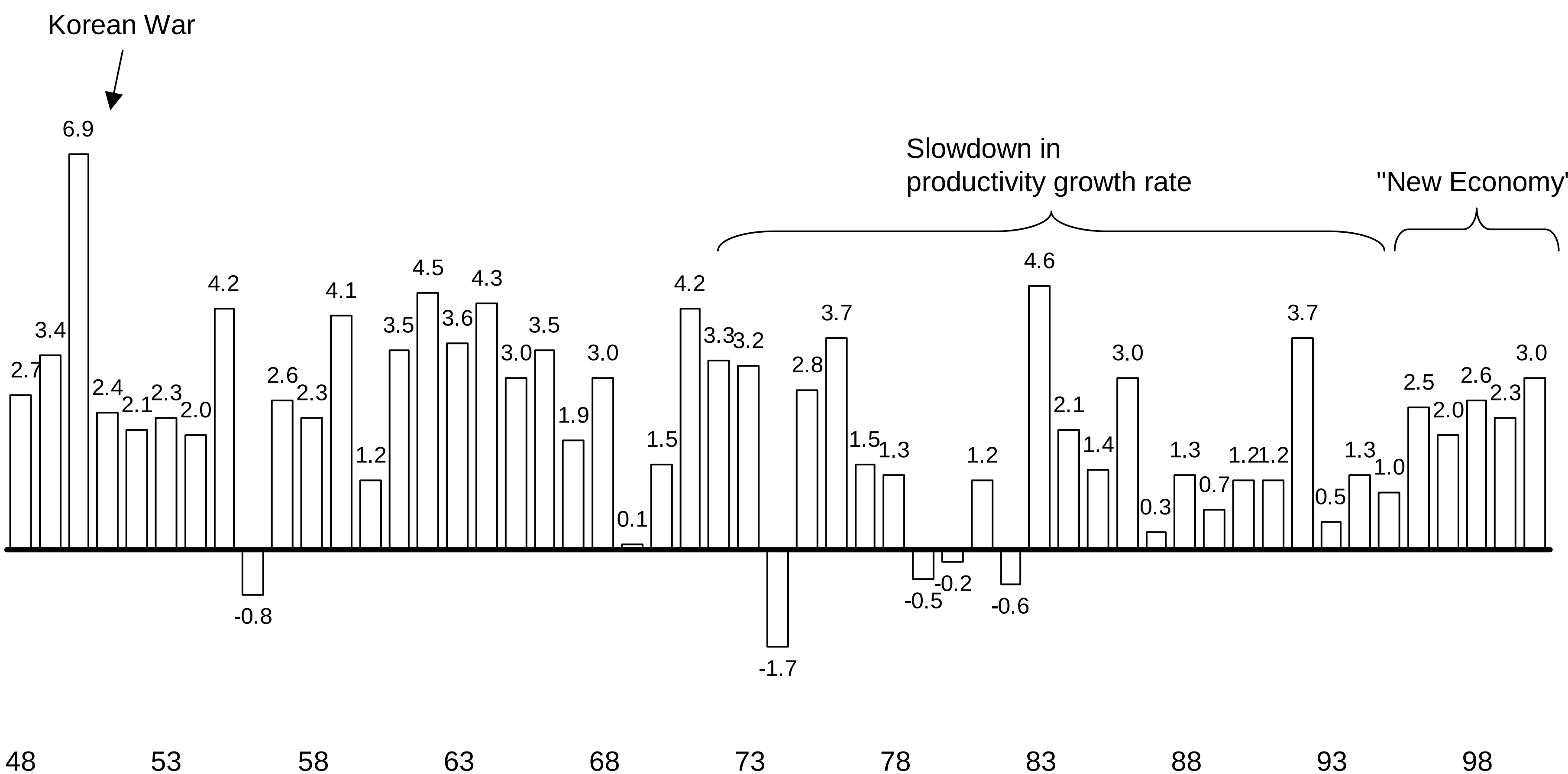
Source: BLS

Exhibit 3

ANNUAL U.S. LABOR PRODUCTIVITY GROWTH RATE*

Annual growth, nonfarm business

Percent



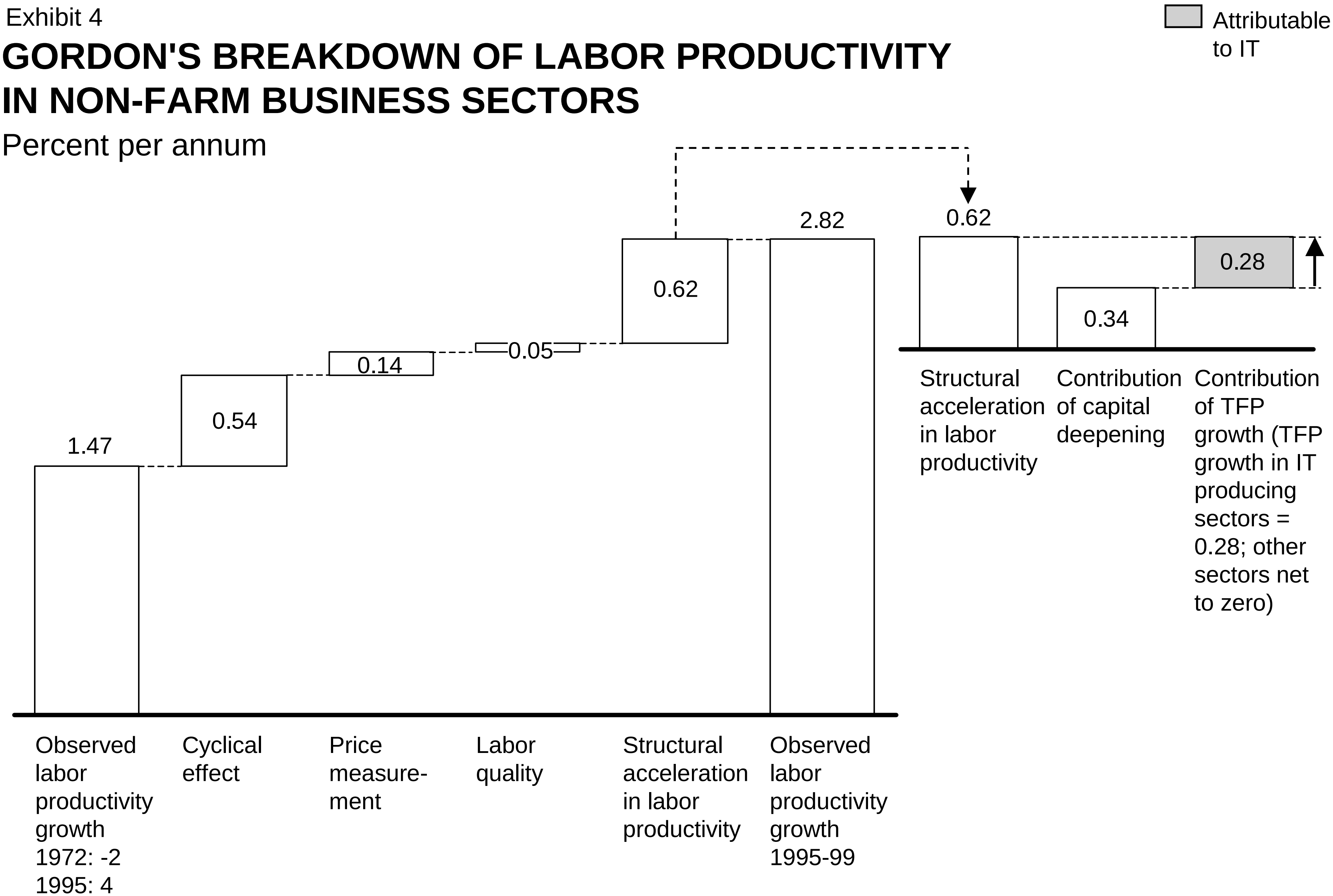
* Revised data as of August 7, 2001

Source: BLS

Exhibit 4

GORDON'S BREAKDOWN OF LABOR PRODUCTIVITY IN NON-FARM BUSINESS SECTORS

Percent per annum

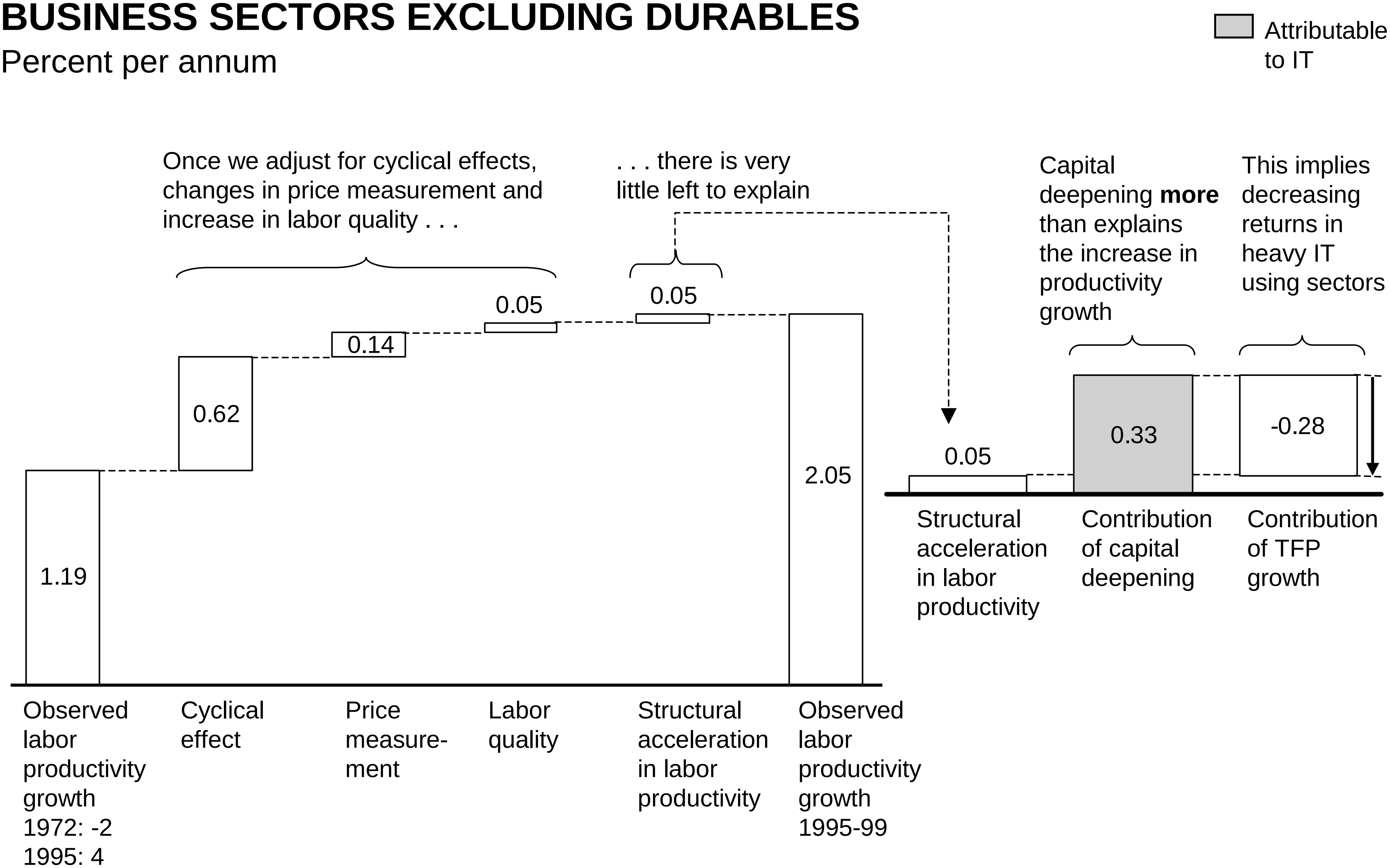


Source: Gordon, Robert. "Does the New Economy Measure up to the Great Inventions of the Past?" (May 2000)

Exhibit 5

GORDON'S BREAKDOWN OF LABOR PRODUCTIVITY IN NON-FARM BUSINESS SECTORS EXCLUDING DURABLES

Percent per annum

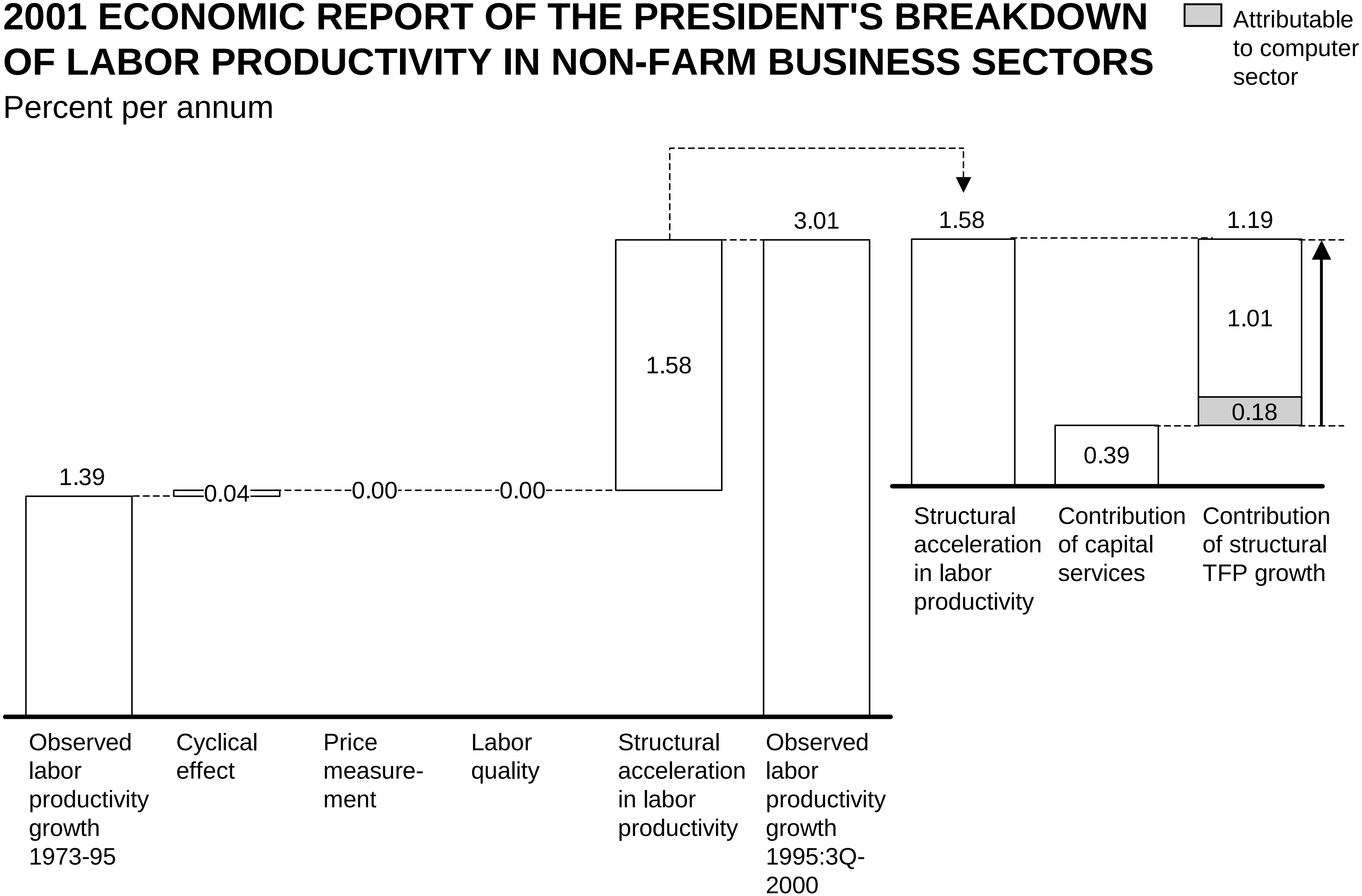


Source: Gordon, Robert. "Does the New Economy Measure up to the Great Inventions of the Past?" (May 2000)

Exhibit 6

2001 ECONOMIC REPORT OF THE PRESIDENT'S BREAKDOWN OF LABOR PRODUCTIVITY IN NON-FARM BUSINESS SECTORS

Percent per annum



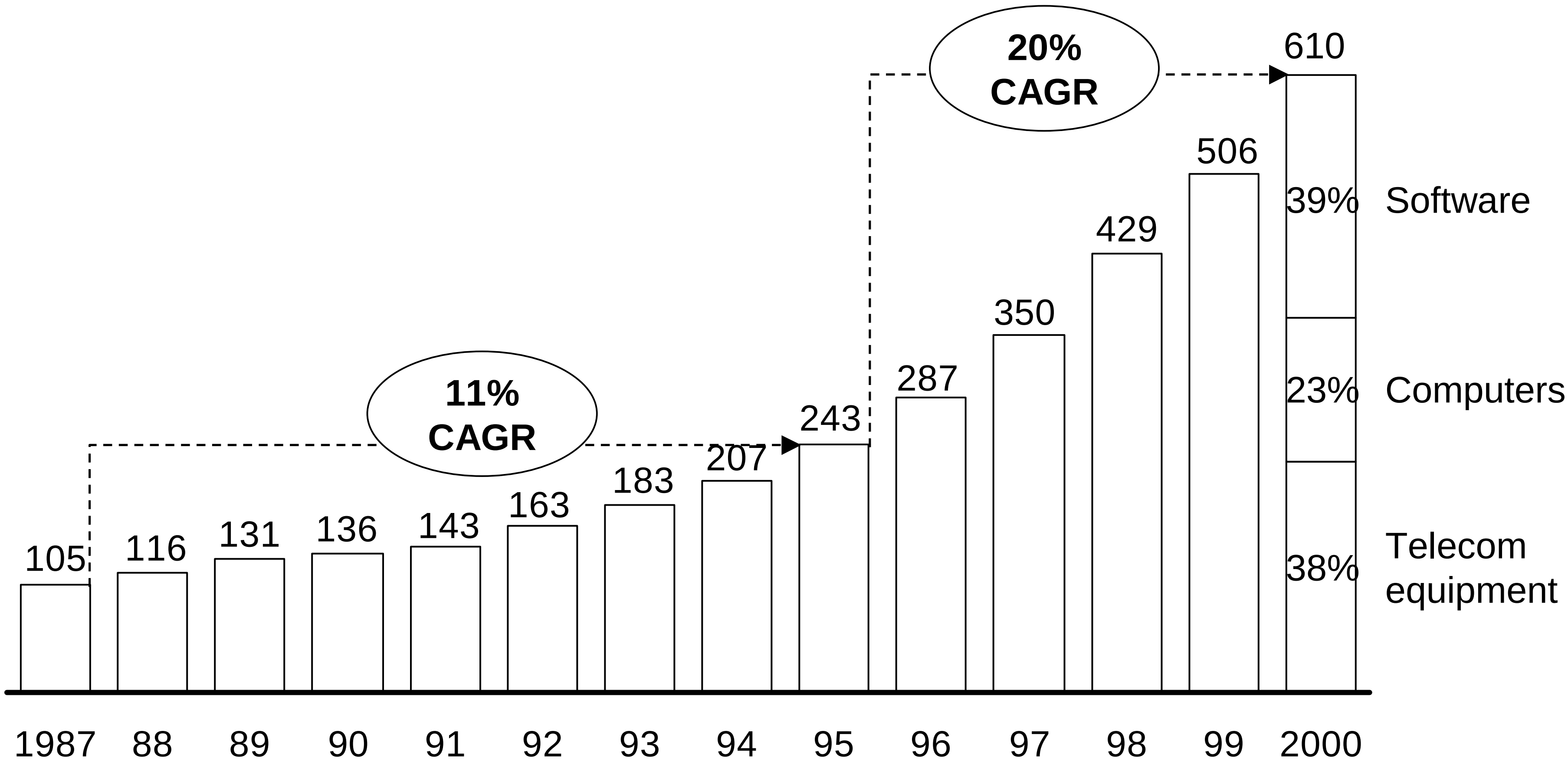
Source: "2001 Economic report of the President", Table 1.1

Exhibit 7

REAL IT INVESTMENT GROWTH HAS ACCELERATED

Real IT investment*

1996 $ Billions



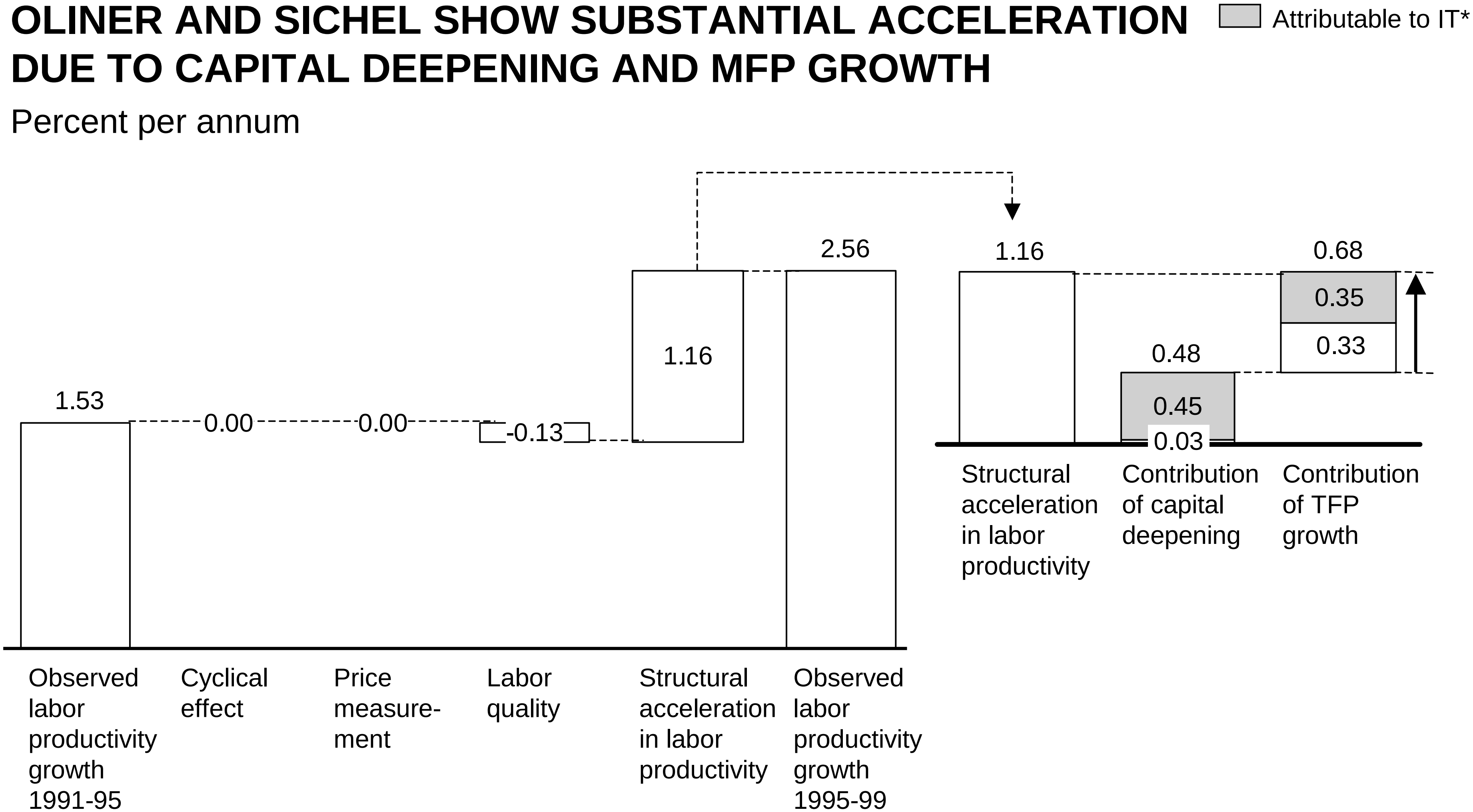
* BEA NIPA information processing equipment and software investment

Source: BEA; MGI analysis

Exhibit 8

OLINER AND SICHEL SHOW SUBSTANTIAL ACCELERATION DUE TO CAPITAL DEEPENING AND MFP GROWTH

Percent per annum



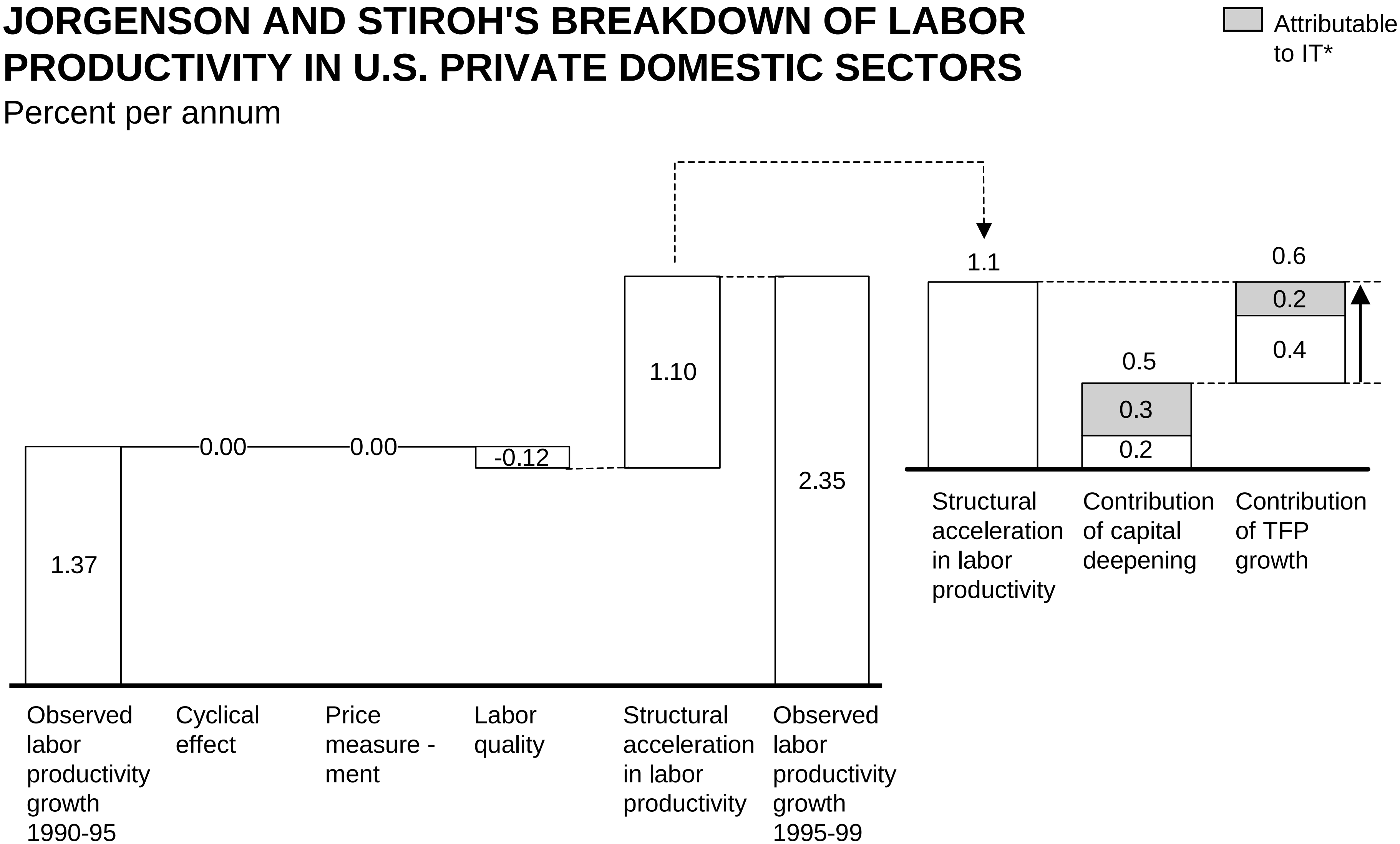
* IT-related capital deepening refers to investment in IT by all industries; TFP growth from IT refers to TFP growth in the IT production sector only

Source: Oliner, Stephen D. and Daniel E. Sichel. "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?" (March 2000)

Exhibit 9

JORGENSON AND STIROH'S BREAKDOWN OF LABOR PRODUCTIVITY IN U.S. PRIVATE DOMESTIC SECTORS

Percent per annum

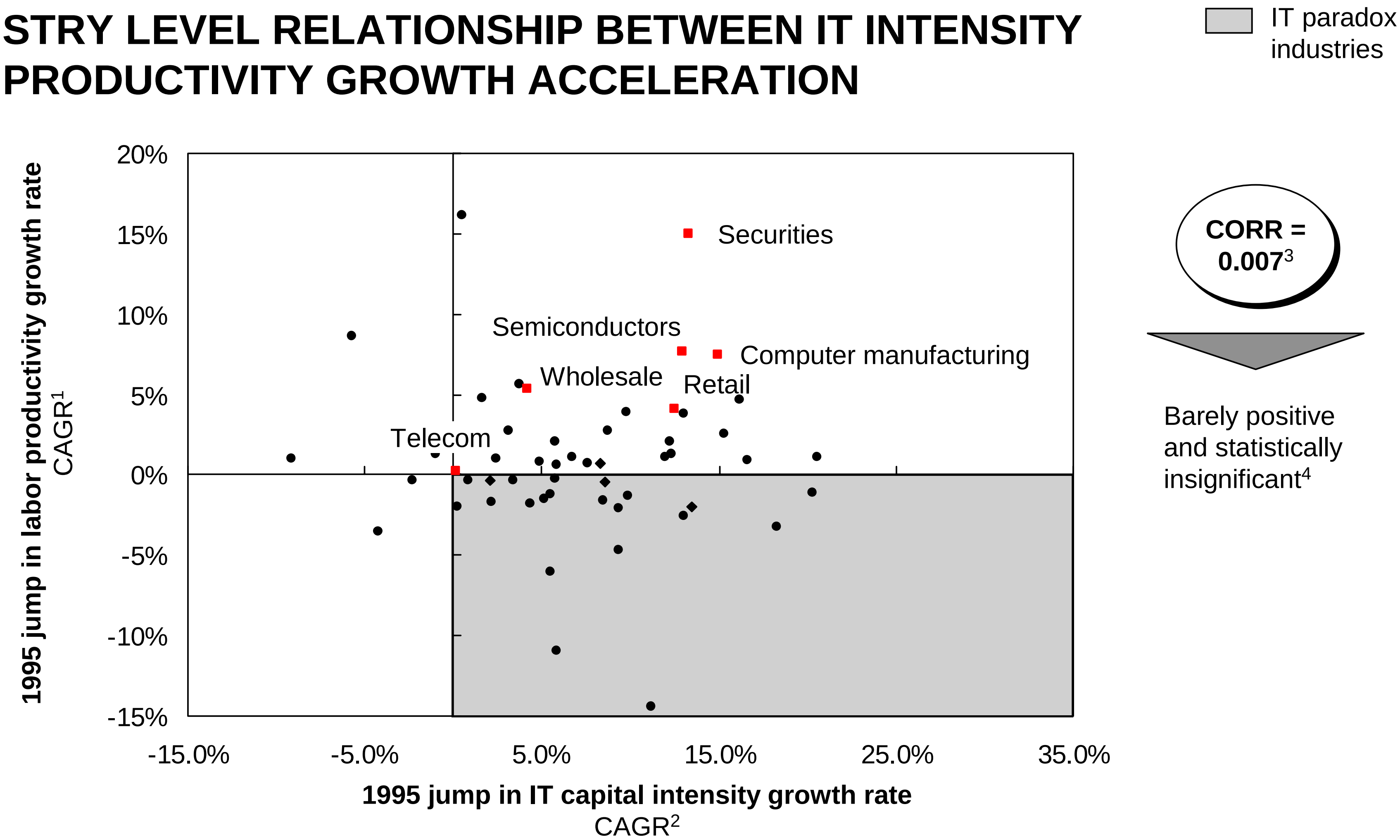


* IT-related capital deepening refers to investment in IT by all industries, TFP growth from IT refers to TFP growth in the IT production sector only

Source: Jorgenson, Dale W. & Kevin J. Stiroh. “Raising the Speed Limit: U.S. Economic Growth in the Information Age.” (May 2000)

Exhibit 10

INDUSTRY LEVEL RELATIONSHIP BETWEEN IT INTENSITY AND PRODUCTIVITY GROWTH ACCELERATION



1 Acceleration in real value added per PEP growth rate between 1987-95 and 1995-99

2 Acceleration in real IT capital stock per PEP growth rate between 1987-95 and 1995-99

3 Excludes farms, coal mining, and metal mining industries due to low initial levels of IT capital stock and holding companies for measurement reasons (see measurement appendix for details)

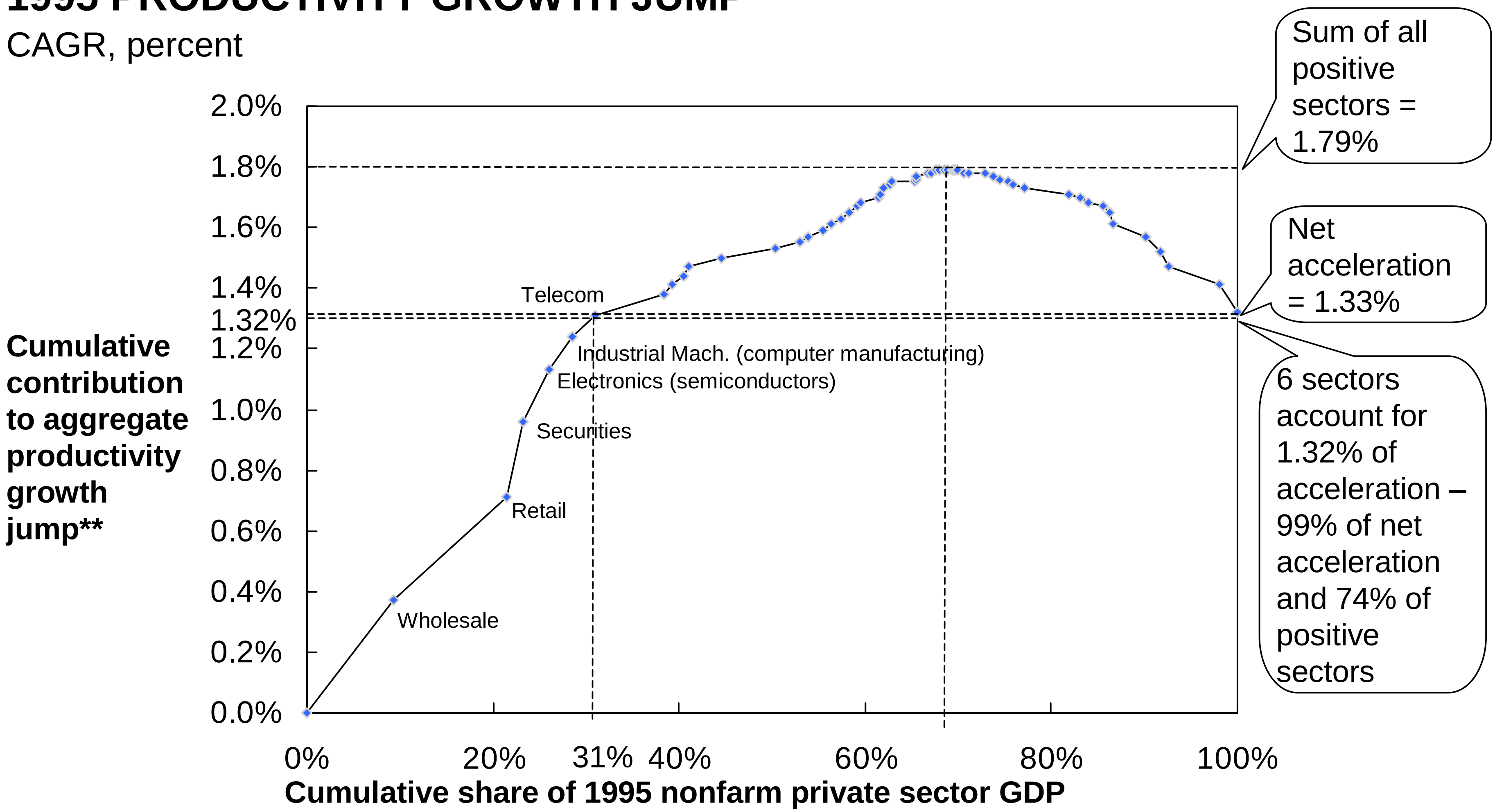
4 Although weighting each sector by its share of employment yields a statistically significant correlation of 0.26, even the weighted result becomes statistically insignificant if the 6 "jumping" sectors are excluded

Source: BEA; MGI analysis

Exhibit 11

CUMULATIVE PRODUCTIVITY CONTRIBUTION DIAGRAM*: 1995 PRODUCTIVITY GROWTH JUMP

CAGR, percent



* Sunrise productivity diagram in Harberger, Arnold, "A Vision of the Growth Process," *AER*, Vol. 88, No.1 (1998

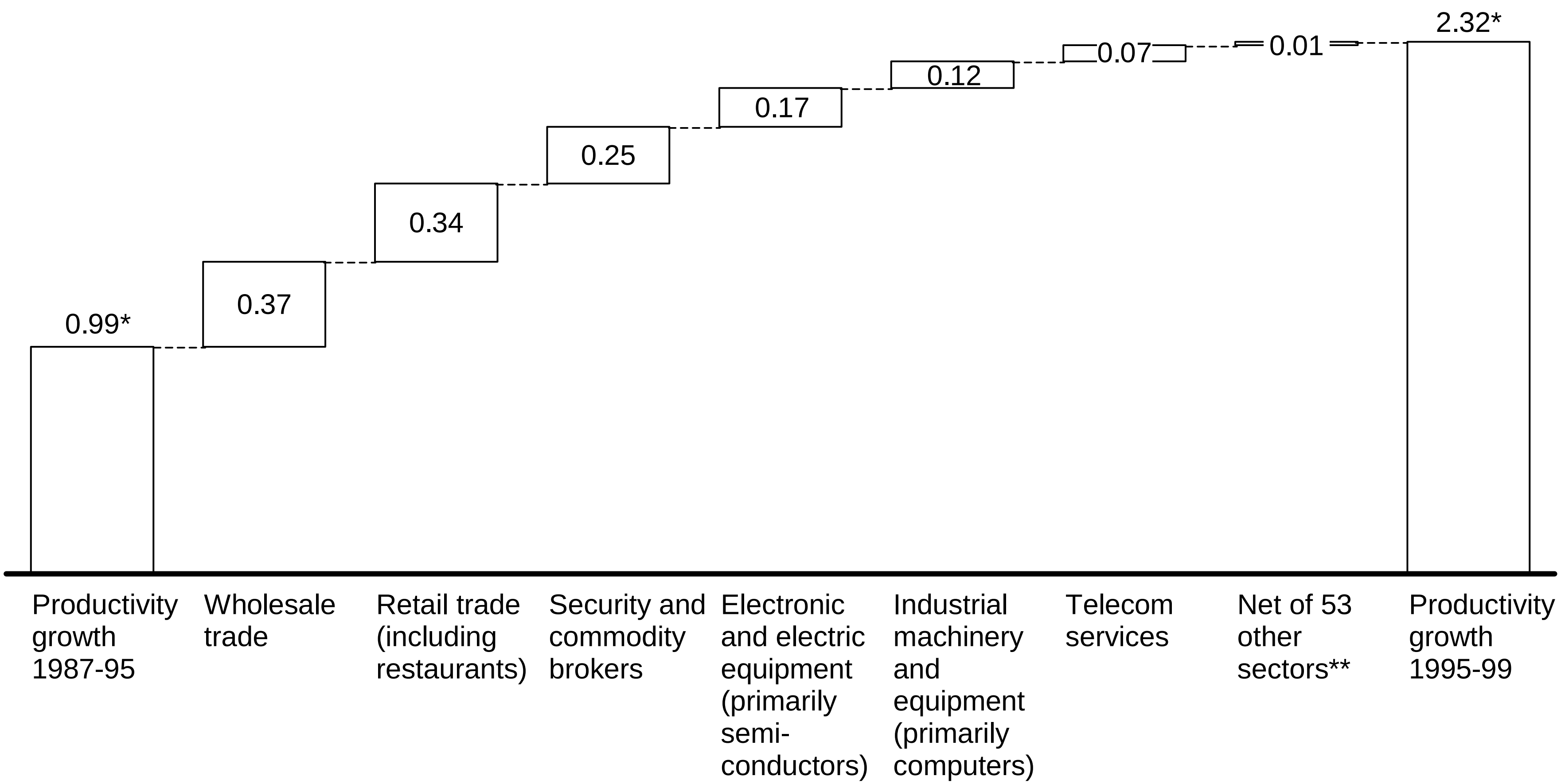
** Excludes contribution of farms and government; holding sector contribution distributed among all sectors other than top 6 contributors. Industry-level analysis relies upon BEA sector data, which differ slightly from the widely publicized BLS aggregate data shown in Exhibit 1

Source: BEA; MGI analysis

Exhibit 12

CONTRIBUTION TO 1995 PRODUCTIVITY ACCELERATION

CAGR*, percent



* Industry-level analysis relies upon BEA sector data, which differ slightly from the widely publicized BLS aggregate data shown in Exhibit 1

** 28 sectors made small positive contributions (totaling +0.47) and 25 sectors made small negative contributions (totaling -0.46)

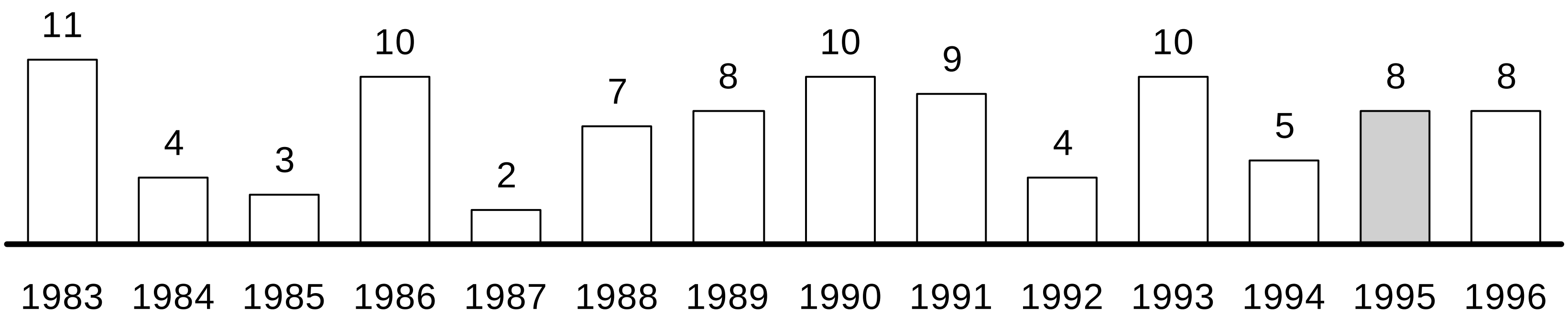
Note: Holdings and other investment offices not classified as a jumping sector because of measurement issues. See appendix of Synthesis chapter and Measurement Appendix for details

Source: BEA; MGI analysis

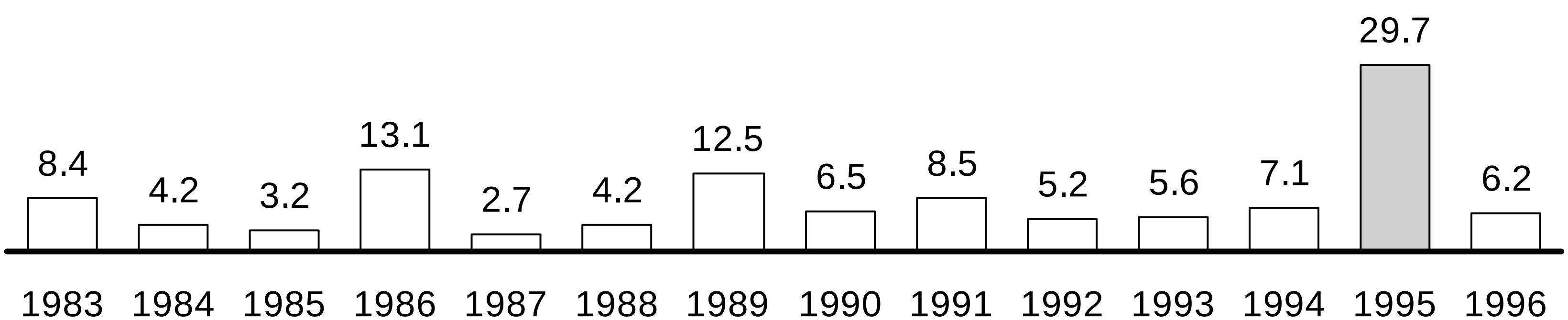
Exhibit 13

IN 1995 THE NUMBER OF SECTORS WITH PRODUCTIVITY GROWTH JUMPS WAS NOT UNUSUAL BUT THE SIZE OF THE SECTORS WAS

Number of jumping sectors*



Share of employment in jumping sectors*
Percent share



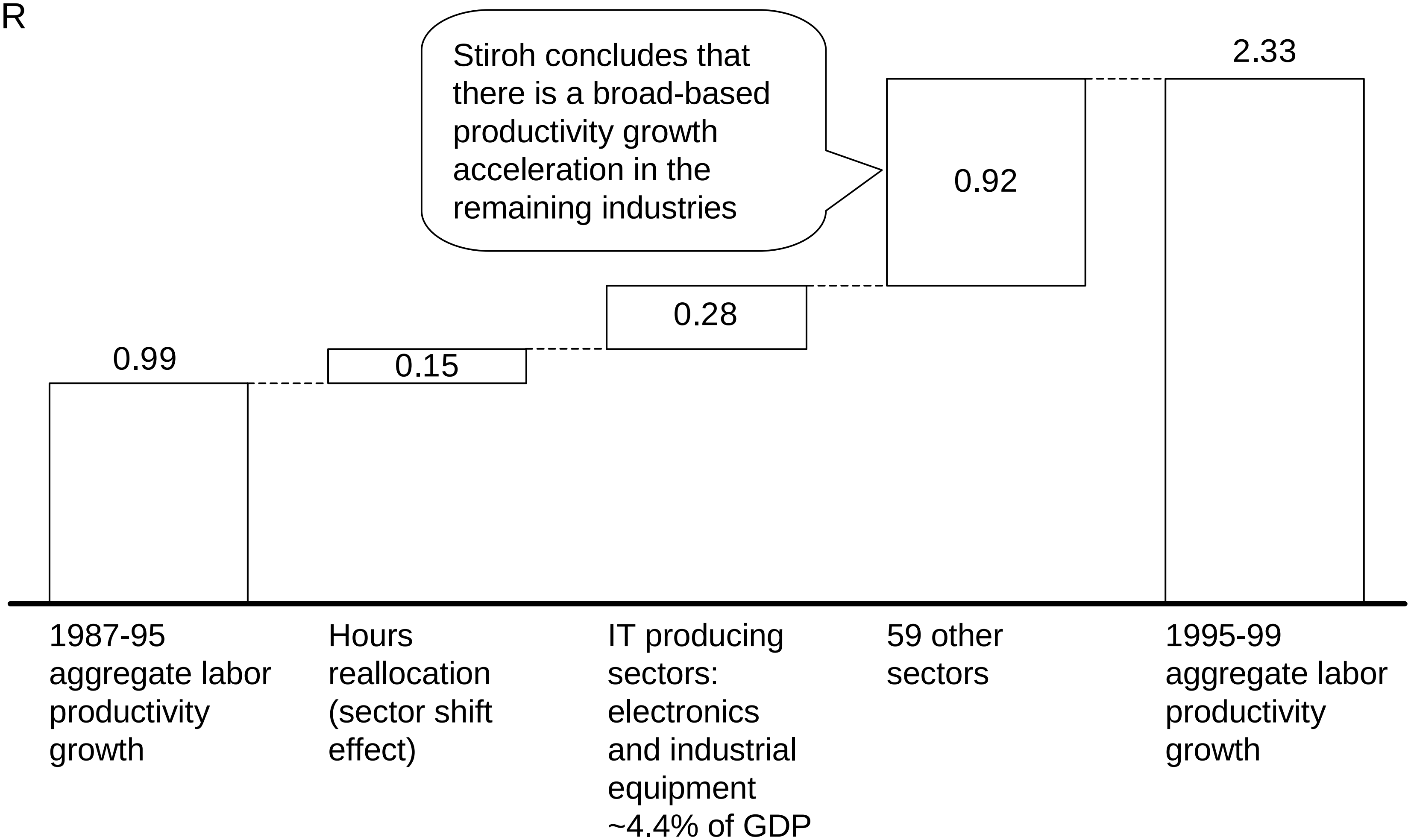
* A sector is classified as "jumping" in year Y if its compounded annual growth rate of productivity for years Y through Y + 3 is at least 3% higher than it was for years Y - 3 to Y

Source: BEA; MGI analysis

Exhibit 14

CONTRIBUTION TO 1995 LABOR PRODUCTIVITY GROWTH ACCELERATION USING STIROH'S VALUE-ADDED PRODUCTIVITY*

CAGR



* Striroh uses real value added per FTE. MGI uses real value added per PEP. PEP includes FTE and self-employed

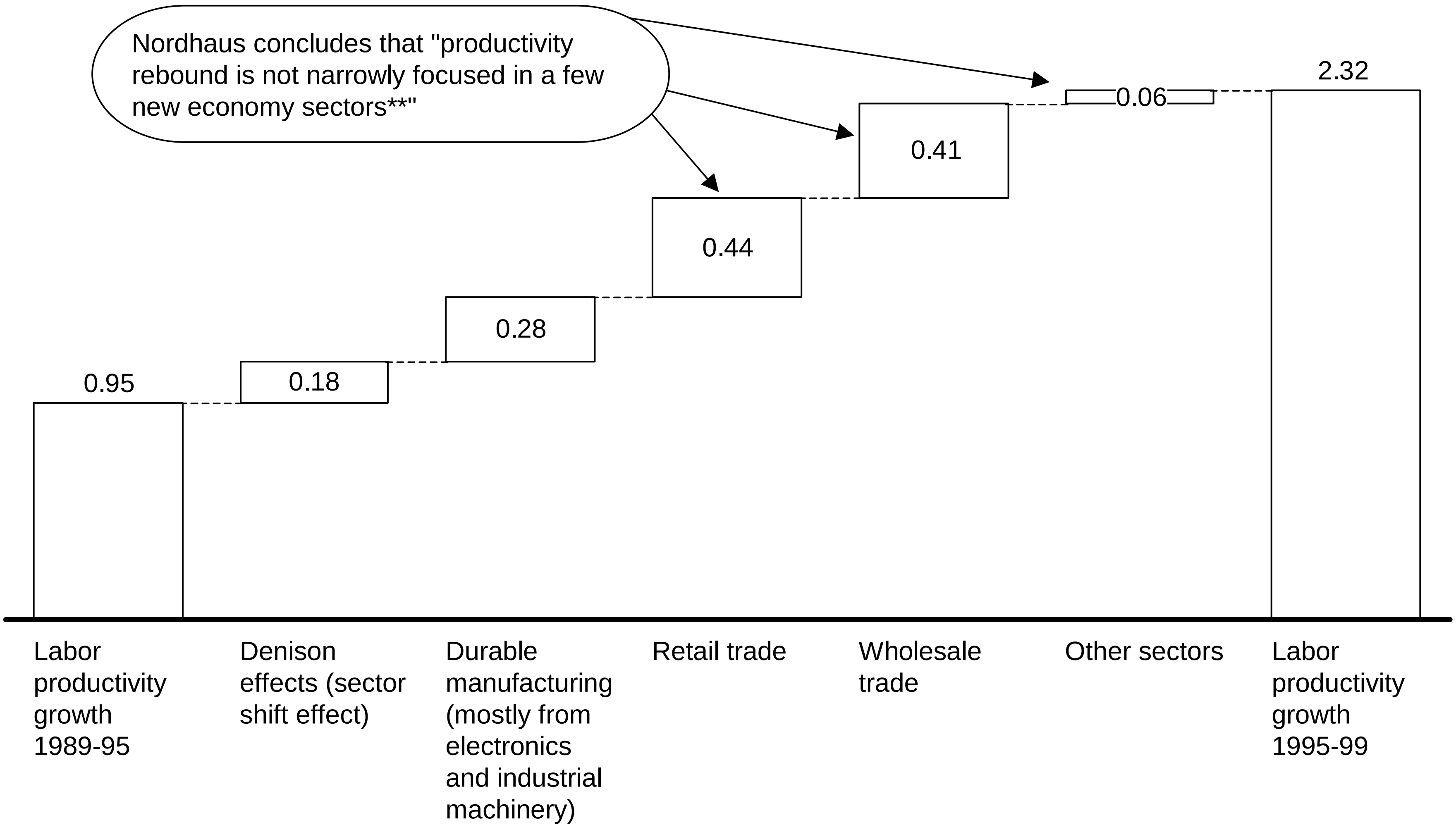
** Stiroh does not calculate contributions of wholesale, retail, securities, and holding industries separately

Source: Stiroh, Kevin J. "Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" (January 2001): Table 8.

Exhibit 15

CONTRIBUTION TO 1995 LABOR PRODUCTIVITY GROWTH ACCELERATION USING NORDHAUS' VALUE-ADDED PRODUCTIVITY*

CAGR*



* Nordhaus uses real value added per hour. Hours data are from an unpublished BEA data set

** Defined by Nordhaus as IT producing

Source: Nordhaus, William. "Productivity Growth and the New Economy." (January 2001): Figure 13; McKinsey analysis

Exhibit 16

McKINSEY GLOBAL INSTITUTE APPROACH

Methodology

Aggregate analysis

- Understand drivers of recent increase in labor productivity growth
- Identify key sectors to be analyzed

In-depth sector level analysis

- Measure sector performance
- Quantify IT spending
- Understand drivers of productivity changes

Firm-level analysis

- Describe firm-level actions leading to productivity growth
- Understand how IT has impacted firm-level performance
- Understand the drivers of IT spending

Questions to be answered

- What drove the 1995-2000 productivity growth jump and how sustainable is it?
- What has been the impact of IT?
  - What types of investments drove productivity growth acceleration?
  - What, if anything, has been different since 1995?
- What are the continuing and future sources of value IT can deliver?

Source: McKinsey analysis

Exhibit 17

Sectors studied

WE SELECTED A MIX OF "JUMPING" SECTORS AND "PARADOX" CASES

	No IT intensity increase	IT intensity increase
Productivity growth increase	"Non-IT story" cases • Lumber and wood products • Farms • Coal mining	"Jumping" sectors • Wholesale trade • Security and commodity brokers • Semiconductors • Computer manufacturing • Retail trade • Telecom (mobile and long-distance voice)
No productivity growth increase	"No story" cases • Construction • Trucking and warehousing • Insurance	"Paradox" cases • Retail banking • Hotel and lodging places • Telecom (long distance data)

Source: BEA; MGI analysis

Exhibit A1

DISAGGREGATION OF LABOR PRODUCTIVITY GROWTH

Labor productivity	=	Output per hour		
Growth in labor productivity	=	Contribution from capital deepening	+	Contribution from total factor productivity growth

Capital deepening

- An increase in capital intensity
- Substitution of capital/equipment for labor
- Assumes a historical rate of return (output to capital ratio)

Total factor productivity growth (TFP)

- The increase in labor productivity beyond capital deepening
  - Positive TFP growth implies higher economic returns driven by IT spillover effects, changes in organization of functions and tasks, workflow redesign, etc.
  - Negative TFP growth implies lower economic returns due to over-investment, low marginal utility of additional functionality, failed IT projects, etc.

Exhibit A2

MATHEMATICAL DERIVATION OF SECTOR LABOR PRODUCTIVITY

It can be shown that at the aggregate level

$$\text{Productivity growth} = \underbrace{(\text{V.A. growth} - \text{Employment growth})}_{\substack{\text{Closely approximates}\\ \text{productivity growth and}\\ \text{allows for adjustment using}\\ \text{Fisher superlative index}}} \times \underbrace{\frac{\text{Employment in period 1}}{\text{Employment in period 2}}}_{\substack{\text{Ensures the accuracy}\\ \text{of the disaggregation}\\ \text{of productivity growth}}}$$

$$\begin{array}{l}\text{Contribution of sector } i \text{ to}\\ \text{aggregate product growth}\end{array} \approx \left(\begin{array}{l}\text{Contribution of}\\ \text{sector } i \text{ to}\\ \text{VA/GDP growth}\end{array} - \begin{array}{l}\text{Contribution of}\\ \text{sector } i \text{ to}\\ \text{employment growth}\end{array}\right) \times \frac{\text{Agg. employment in period 1}}{\text{Agg. employment in period 2}}$$

Exhibit A3

AGGREGATION OF PRODUCTIVITY GROWTH – SEPARATING OUTPUT AND EMPLOYMENT GROWTH

$$\boxed{\text{Prod} = \frac{VA}{H}}$$

$$\Delta\left(\frac{VA}{H}\right) = \frac{VA_2}{H_2} - \frac{VA_1}{H_1} = \frac{VA_2\, H_1 - VA_1\, H_2}{H_1\, H_2}$$

$$= \frac{VA_2\, H_1 - VA_1\, H_1 - VA_1\, H_2 + VA_1\, H_1}{H_1\, H_2}$$

$$= \frac{VA_2\, H_1 - VA_1\, H_1 - (H_2\, VA_1 - H_1\, VA_1)}{H_1\, H_2}$$

$$= \frac{\Delta VA\ H_1 - \Delta H\ VA_1}{H_1\, H_2}$$

Where

VA_1 =	Value added in period 1
H_1 =	Employment in period 1
Prod =	Productivity
$\dot{\text{Prod}}$ =	Change in productivity
$\dot{VA}$ =	Change in value-added

$$\dot{\text{Prod}} = \frac{\Delta\left(\frac{VA}{H}\right)}{\frac{VA_1}{H_1}} = \frac{\cancel{H_1}\ (\Delta VA\ H_1 - \Delta H\ VA_1)}{VA_1\ \cancel{H_1}\ H_2}$$

$$= \frac{\Delta VA\ H_1}{VA_1\ H_2} - \frac{\Delta H\ VA_1}{VA_1\ H_2}$$

$$= \dot{VA}\ \frac{H_1}{H_2} - \frac{\Delta H}{H_1}\ \frac{H_1}{H_2}$$

$$= \frac{H_1}{H_2}\left(\dot{VA} - \dot{H}\right)$$

Exhibit A4

AGGREGATION OF PRODUCTIVITY GROWTH – DERIVATION OF SECTOR "WEIGHTS"

$$\boxed{\dot{Prod} = \frac{H_1}{H_2}\left(\dot{VA} - \dot{H}\right)}$$

To take into consideration the non-additivity of real numbers, we use the latest GDP growth contribution formula developed by Yuri Dikanov from the World Bank which is described in the October 1999 Survey of Current Business. (See the article, "A Preview of the 1999 Comprehensive Revision of the National Income and Product Accounts: Statistical Changes" by Brent R. Moulton and Eugene P. Seskin)

$$\dot{VA} = \Sigma f(P,Q)$$

Similarly $\dot{H} = \Sigma \frac{H_{i1}}{H_1} \times \dot{H_i}$

$$\Rightarrow \dot{Prod} = \frac{H_1}{H_2} \Sigma \left(\frac{VA_{i1}}{VA_1} \times \dot{VA_i} - \frac{H_{i1}}{H_1} \times \dot{H_i}\right)$$

$$\Rightarrow \text{Contribution of } i \approx \frac{H_1}{H_2}\left(\frac{VA_{i1}}{VA_1} \times \dot{VA_i} - \frac{H_{i1}}{H_1} \times \dot{H_i}\right)$$

Where

	VA_{i1} =	Value added in sector i in period 1
	H_{i1} =	Employment in sector i in period 1
	Prod =	Productivity
	$\dot{Prod}$ =	Change in productivity
	$\dot{VA}$ =	Change in value added

Exhibit A5

COMPARISON OF METHODOLOGIES

High-level methodology and concepts

Differentiate output effect and hour effect, leading to isolating the mix effect and the "within" effect
- The "within" effect is approximated by share of value added
- The mix effect is dependant of relative productivity and relative employment growth

	MGI	Stiroh	Nordhaus
Basis for disaggregation	• Disaggregate productivity growth	• Disaggregate productivity delta	• Disaggregate productivity growth
Superlative indexing	• Integrates Fisher	• Approximates Fisher by Tornqvist	• Neglects Fisher or other superlative index • Disaggregation math cannot allow for Fisher
Assumption on employment	• Has to distribute relative changes in aggregate employment	• Also has to distribute change in employment for full accounting of contribution • Stops short and has a lump number	• Does not need any assumption on employment

Exhibit A6

CAUSALITY FRAMEWORK FOR JUMPING SECTORS

	Factor	Description
External factors	• Demand factors	• Macro-economic/financial markets, consumer preferences, etc.
	• Managerial and technological innovations	• Technological or managerial innovations, in own or related industry
	• Product market regulation	• Regulatory environment, government/agency policies
	• Up-/downstream industries	• Industry structure, changes in up-/downstream industries
	• Measurement issues	• Measurement issues causing a measured jump
Industry dynamics	• Competitive intensity	• Number of competitors, entries/exits, consolidation
	• Prices/demand effects	• Changes in prices and/or demand
Firm-level factors	• Output mix	• Mix shift between products/services with different productivity levels
	• Capital/technology/capacity	• Technology, capital/labor substitution, capacity creating investment
	• Intermediate inputs/technology	• More inputs, higher value/quality inputs (including embedded technology)
	• Labor skills	• Skills, training
	• Labor economies of scale	• Leverage of fixed labor
	• OFT/process design	• Organization of functions and tasks

Exhibit A7

CAUSALITY FRAMEWORK FOR PARADOX CASES

External factors	• Demand factors/capital markets	• Macroeconomic issues/financial markets
	• Product market regulation	• Regulatory environment, government policies
	• Y2K	• The existence of systems whose utility would have expired on January 1, 2000, due to two-digit date codes
	• Unmeasured consumer benefits	• The difficulty of measuring all benefits received by consumers from certain IT investments/functionality
Industry dynamics	• Low competitive intensity	• Imperfect competition in some segment(s) of the industry
	• Lower than expected demand	• Incorrect industry beliefs about the future trajectory of demand for specific goods or services
Firm-level explanation for lack of productivity enhancement	• Unmeasured convenience to consumers	• IT intensity surge increased consumer surplus
	• Y2K compliance	• IT intensity surge required to avoid systems failure but did not increase productivity
	• Software and hardware that did not yield expected returns	• IT intensity surge failed to increase productivity because some portion of investment, to date, has not lived up to expectations
	• Excessive/unnecessary investment	• IT intensity surge failed to increase productivity because all signs point to some portion of investment having been wasted with low probability of future payoff

Synthesis

INTRODUCTION

The United States experienced a labor productivity growth rate of approximately 2.5 percent between 1995 and 2000.[1] This figure, if sustained, has dramatic implications for the citizens, firms, and government of the US. In the long run, a nation's labor productivity growth rate dictates the speed at which it can improve its standard of living. The 2.5 percent 1995-2000 figure represents a dramatic improvement from the 1.4 percent growth rate achieved between 1972 and 1995. It is also within sight of the high rate (2.9 percent) achieved during the 1947-72 period, now considered a golden age of economic and productivity performance (Exhibit 1).

Productivity acceleration during 1995-2000 is particularly interesting due to the potential role played in it by information technology (IT[2]). Until 1995, the aggregate impact of the IT revolution seemed best captured by Robert Solow's 1987 quip that, "You can see the computer age everywhere but in the productivity statistics." The 1995-2000 acceleration could represent the resolution of this "Solow paradox." There is no doubt that it coincided with a period of massive investment in IT. From 1995-2000, the annual rate of growth in real IT investment was 20 percent, nearly double the rate from 1987-95 (Exhibit 2). What is less clear is whether it was these post-1995 IT investments themselves, previous (pre-1995) IT investments, or factors unrelated to IT that actually led to the productivity acceleration.

What caused the 1995-2000 acceleration in US labor productivity growth – in particular, what role did IT play – and how sustainable was it? These are the questions that the McKinsey Global Institute (MGI) sought to answer when it began work on this report, "US Productivity Growth, 1995-2000," more than a year ago. The economic situation has changed considerably in the past year. Even prior to the events of September 11, 2001, the rate of economic growth had slowed and the stock markets had retreated as consumer and business confidence dropped. Now, in the minds of many economists, tragic terrorist attacks may push the US into a recession. What are the implications for productivity growth? If historical precedents hold, the effect of any potential recession on labor productivity growth

[1] 2.5 percent represents nonfarm, private sector labor productivity as measured and reported by the Bureau of Labor Statistics (BLS). We employ the word "approximately" because the BLS has made and is likely to continue making revisions to these figures.

[2] We use the acronym "IT" to describe information and communications technology. IT is intended to convey the same meaning as the term "ITC," which also refers to all information and communications technology (i.e., hardware, software, communications equipment, and other digital technologies).

over the next four-year period should actually be minimal. The more important issues in the longer term remain the causes and sustainability of the 1995-2000 productivity growth acceleration.

Issues and analytic approach

Prominent economists, employing the aggregate and industry-level data compiled by government statistical agencies, have put forth a variety of perspectives on the degree to which productivity growth in the mid- to late-1990s was structural, attributable to IT, and widespread.

The two main topics of contention are: how much of the jump was cyclical as opposed to structural, and how much of the structural jump was driven by investments in IT? Results to date have differed dramatically, with the structural portion of the post-1995 labor productivity performance ranging from 30 percent to 100 percent. There are two very extreme camps on the subject of cyclicality. One view, espoused most notably by Robert Gordon, finds a strong cyclical component to the labor productivity jump; the other finds little or no evidence of cyclicality. Opinions and analyses diverge similarly on the sources of the structural growth, from a predominant role of IT to a minimal contribution from the usage of IT. (See "Objectives and approach" chapter for details.[3])

"US Productivity Growth, 1995-2000" builds on the diverse insights, published and unpublished, generated by economists from the academic and policy communities. The key difference between this report and earlier work lies in contrasting approaches. Previous work has been done at the aggregate level, where conclusively determining the sources of the jump, the role of IT, and the division between cyclical and structural causes has been extremely difficult. Our intent has been to pick up where previous work left off by diving more deeply into the industry- and firm-level factors behind the productivity acceleration than is possible when conducting analysis based primarily upon national accounts data.

Our departure point was targeted aggregate analysis. It revealed two findings that determined our approach to the study:[4]

¶ Only six sectors of the economy comprising roughly 30 percent of GDP contributed 99 percent of the net 1995-99 productivity growth acceleration [5] (Exhibit 3).

---

[3] This introduction to the "Synthesis" chapter summarizes at a high level issues explored in greater depth in the "Objectives and Approach" chapter.

[4] This analysis, and the vast majority of our case study work, was based on the time period 1987-99 for reasons of data availability.

[5] The six sectors represent 31% of non-farm, private sector GDP.

¶ Productivity growth did not accelerate in many other sectors, in spite of significant increases in IT intensity. Inspection of Exhibit 4 reveals that in many sectors, jumps in IT intensity seem not to have been associated with acceleration in productivity growth.[6]

These findings led us to scrutinize two types of sectors in great detail: "jumping sectors" and "paradox sectors." We studied all of the six sectors whose productivity growth accounted for the economy-wide acceleration. We classified them as jumping sectors because their productivity growth (and IT intensity) jumped during 1995-99. In addition, we studied three paradox sectors in which IT intensity acceleration did not yield productivity acceleration (Exhibit 5).

¶ **Importance of the jumping sectors.** First, absent their performance, a change in the US productivity growth trajectory would not have taken place. Second, because each sector also experienced a surge in IT intensity, they represented an ideal laboratory in which to investigate the relationship between technology and productivity growth.

¶ **Potential insights from studying paradox cases.** First, we wanted a control group, to determine whether broad links we saw between IT and productivity growth in the six key contributing sectors did or did not hold in other parts of the economy. Second, we hoped to draw generalizations about the reasons IT is unable to generate productivity gains in some sectors of the economy.

Although these case studies began with and linked back to the industry-level government productivity statistics, they also drew heavily upon both McKinsey's sector-specific industry expertise, and extensive quantitative and qualitative

---

[6] Exhibit 4 reveals that the 1995 jump in the growth rate of IT capital intensity (defined as IT capital per persons employed in production) does not correlate directly with the 1995 productivity growth jump at the industry level. However, we do not believe that such high-level correlation can give a definitive answer to the question of the relationship between productivity growth and IT for many reasons, of which five key ones follow: First and foremost, correlation does not imply causality. Second, the time lag between changes in IT intensity and changes in productivity growth could affect the correlation's results outcome. We analyzed this factor and determined that adding time lags did not change the results of the correlation. (The level and significance of the correlation increased, but the result was still not statistically significant, even with the three-year lag that yielded the smallest p-value). Third, the relationship between other, non-IT capital and productivity growth could affect the result. (We controlled for other types of capital and found that doing so did not yield a statistically significant result.) Fourth, the correlation could be sensitive to how the economy is subdivided. We used BEA sector definitions, recognizing that if it were possible to subdivide large sectors such as wholesale and retail, the results of the correlation might be different. A highly imperfect proxy for subdividing such sectors into their smaller components is weighting each sector by its employment share. A weighted (by employment) correlation, giving larger sectors such as retail more weight in the correlation, yields a positive and significant relationship for all US sectors, but an insignificant correlation outside the six sectors that contributed most to the productivity growth jump. This finding highlights the need to investigate the actual sources of productivity acceleration in these six sectors. Finally, the definition of the productivity measure (which could be based on gross output, value added, or TFP) impacts results significantly. It is for all of these reasons that we focus on the incontrovertible finding that productivity growth did not accelerate in many sectors of the economy, in spite of significant increases in IT intensity, rather than on the results of the correlation itself.

external research, including discussions with executives at firms important to our case studies. This detailed, micro-level analysis enabled MGI to develop a perspective on what influenced productivity performance and what was the role of IT in the sectors studied. We believe that this view from the trenches and our access to industry experts makes the contribution of this analysis distinctive.

Structure of the chapter

The remainder of this chapter synthesizes the key conclusions that our case studies, taken together, have generated. It is structured around two topics:

¶ **Explaining the 1995-99 productivity growth acceleration.** This first section describes in which six sectors the economy-wide productivity growth acceleration was concentrated and the causal factors behind their productivity growth.

¶ **Appraising the contribution of IT to productivity growth.** This second section draws upon conclusions from the jumping and paradox sectors, as well as additional aggregate findings, to set forth a perspective on what IT *is* and *is not* with respect to productivity growth.

EXPLAINING THE 1995-99 PRODUCTIVITY GROWTH ACCELERATION

The 1995-99 productivity growth jump was concentrated in six sectors of the economy. The contribution of these sectors represented 74 percent of the total contributed by all the sectors that positively impacted the economy-wide productivity growth acceleration. Overall, the productivity growth jump was attributable largely to structural changes, though cyclical factors played a role in select instances. The discussion that follows describes the highly concentrated nature of the aggregate productivity acceleration and examines the sources of the acceleration. These sources are captured in a causality framework (Exhibit 6) that reveals the key role of three factors: innovation (product, service, and process), changes in product market regulation, and demand factors (Exhibit 7).[7] Of these, only the demand factors show strong evidence of being influenced by cyclicality. Surprisingly, we found that measurement issues in the six jumping sectors did not contribute to the measured productivity acceleration (see appendix to this chapter for a discussion of measurement findings).

The description of what caused the productivity acceleration operates on two levels. First, it scrutinizes the ways in which both structural factors (i.e., innovation, regulation) and cyclical factors underlay the 1995-99 productivity growth jump in the key contributing sectors. At the same time, it provides operational details to help readers understand how these external factors were able to generate productivity improvement. Where it was important, the application of IT receives special attention. IT was ultimately only one of many operational factors contributing to the jump.

Productivity acceleration came mostly from six sectors

Six sectors were responsible for the 1995-99 productivity growth acceleration: retail, wholesale, securities brokerage, industrial machinery and equipment (primarily computer manufacturing), electronics (primarily semiconductors), and telecommunications (Exhibit 3 and 8). Three facts (Exhibit 9) highlight the unusual contribution of these sectors:

¶ They comprised just 31 percent of non-farm, private sector GDP in 1999.[8]

---

[7] A full moon in the framework represents a factor contributing >50% to the sector's productivity growth jump. A half moon contributed between 10 and 50 percent. An "X" means the factor contributed less than 10 percent.

[8] The six sectors as defined by the Bureau of Economic Analysis (BEA) comprised 31 percent of nonfarm, private sector GDP in 1999. MGI has focused on specific subsectors (i.e., on computer manufacturing and semiconductors

¶ They contributed 1.32 percentage points (99 percent) to the net, economy-wide productivity acceleration of 1.33 percentage points.[9]

¶ Their contribution of 1.32 percentage points represented 74 percent of the sum of all the positive, contributing sectors' acceleration (1.79 percentage points). The contributions of the other sectors were all small.

The existence of six jumping sectors is not unusual. What was unique about 1995 was that the jumping sectors either had very large leaps in productivity (e.g., semiconductors, computer manufacturing) or were very large in terms of employment (e.g., retail, wholesale) (Exhibit 10).

Structural factors: Competition and innovation

Structural factors, in particular product, service, and process innovations, were the most important factors explaining the productivity growth jump, with changes in product market regulation also contributing in select instances. Competition was the key driving force behind the rapid diffusion of these innovations.

¶ Process and service innovation played a key role in the general merchandising (GMS) segment of retail. Pressure from and market share gains by Wal-Mart's successful, innovative business model pushed down margins and yielded productivity-enhancing efforts by competing firms, encouraging the rapid diffusion of best practices (Exhibit 11). The Wal-Mart innovation relied on scale, innovative formats, an efficient logistical chain, and IT solutions such as EDI (electronic data interchange), RF gun scanning and, to a lesser degree, electronic supply chain management. Although better supply chain management primarily enhanced capital productivity, there were some modest spillover benefits for labor productivity.

MGI found that Wal-Mart itself contributed roughly one-third of the retail GMS productivity improvement associated with better organization of processes, functions, and tasks. The remaining two-thirds was attributable to the diffusion of best practices to Wal-Mart's competitors. Rapid productivity improvement by smaller players like Meijers and

---

rather than on all of industrial machinery and equipment and electronics). Therefore, the six sectors as studied by MGI comprised slightly more than 21 percent of GDP in 1999.

9 1.33 percent represents the economy-wide productivity acceleration using BEA, income-side, industry data, and excluding the contribution of farms and government. This figure differs from the private sector, nonfarm productivity acceleration reported by the BLS (1.0 percent), due to the use for labor inputs of BEA persons employed in production (PEP) rather than BLS hours, as well as statistical discrepancies between the income and expenditure side. Stiroh and Nordhaus, who also used BEA industry data, arrived at similar aggregate acceleration figures. BLS' productivity figures have been subject to frequent revision, with implied 1995-99 acceleration moving between 1.0 percent and 1.6 percent over the past year.

Kohl's was a key component. These retailers adopted a formula and format very similar to Wal-Mart's.

¶ Upon the widespread diffusion of the Internet, innovators such as Charles Schwab and E-trade rapidly applied on-line trading to their discount brokerage business models, accelerating the penetration of this low-cost, highly productive format (Exhibit 12). MGI determined that absent online interfaces, on-line brokerage firms would have needed ten times more brokers or customer-facing employees. The adoption of these interfaces has been particularly rapid, from practically 0% in 1995 to 40% of retail brokerage trades in 2000. On-line trading was the only significant instance we identified in which the application of the Internet contributed to the economy-wide productivity growth jump.

¶ Warehouse automation technology in distribution centers contributed significantly to the wholesale productivity growth jump. Relatively simple hardware (barcodes, scanners, picking machines, and other material handling equipment), combined with software (warehouse management systems for inventory control and tracking), allowed wholesalers to partially automate the flow of goods. The most dramatic impact of these systems was on the productivity of the picking, packing, and shipping workforce, which constitutes about 40 percent of the labor force in distribution centers (Exhibit 13). Automation also allowed wholesalers to increase dramatically the capacity (in terms of throughput per square foot) of their distribution centers, which contributed to the consolidation wave in the industry. Adoption of these systems took place due to pressure from retail consolidation.

¶ In the semiconductor industry, the most significant factor causing the dramatic productivity improvement during 1995-1999 from already high levels was the increased frequency of release of newer chips (or shortening of the product life cycle). In addition to this shortening product cycle, it may be possible that the overall rate of technology progress, at the cutting edge, accelerated. These dynamics emerged as managerial responses to changes in traditional market forces: a surge in competitive intensity, technological improvements in complementary industries, and an increase in demand. Most significantly, AMD evolved from an outsourcer of manufacturing for Intel to a viable competitor able to close the technology gap (Exhibit 14). Rapidly intensifying competition prompted Intel's managerial decision to release new products more frequently. In addition, improvements in fab ramp up rates (the result of more intensive industry focus on yield, better semiconductor manufacturing and testing equipment, and a variety of other factors) helped facilitate the shortening of the microprocessor lifecycle. This strategic, competitive decision to bring the market closer to the cutting edge was captured by the hedonic price deflator and thus, flowed through to the productivity statistics.

¶ The computer assembly industry's productivity growth benefited (through the sale of higher-performing computers) in two ways from technology innovations in related industries:

- The hardware and software industries created a virtuous cycle in which expectations of faster microprocessors and cheaper memory supported the development of more powerful and demanding software, which, in turn, justified more powerful hardware. For example, the step function improvement of Microsoft's Windows operating system in 1995, coupled with Windows' accelerating post-1995 processing requirements, increased the demand for computers with higher performance (Exhibit 15).

- The integration of new and improved components including storage devices, CD ROMs, and DVDs contributed to the increased value of the computers for customers. Moreover, the performance growth of some of these components (like hard drives) experienced a marked acceleration after 1995.

¶ Technical innovations increased capacity in cellular telephony, driving price reductions, usage jumps, and ultimately productivity jumps in mobile telecom (Exhibit 16). A key innovation was digital cellular equipment based on new standards (e.g., CDMA, TDMA, D-AMPS) that allowed service providers to use spectrum more efficiently.

Smart regulatory changes helped foster competition, decrease prices, and increase output/productivity in two sectors, securities and mobile telecom.

¶ In securities, the SEC's Order Handling and 16th Rules promoted lower spread trading regimes, leading to dramatic price declines and higher trading volumes after 1995. For example, the move of trading increments from 1/8th to 1/16th reduced commissions, which contributed to the increase in trading volumes. This higher trading volume growth yielded labor economies of scale because it did not require commensurate labor growth, as trade processing had been previously significantly automated.[10]

¶ In mobile telecom, the licensing of new spectrum heightened competition and reduced supply constraints (Exhibit 17). Both effects allowed fast decreases in prices and increases in the output of the industry (mobile usage). Finally, the accelerated output growth

---

[10] Labor economies of scale existed because a significant portion of the labor is fixed with respect to trading volume.

contributed to productivity through labor economies of scale and the increased share of employment of a highly productive sector.[11]

One implication of this review is that traditional applications of IT (e.g., warehouse automation systems, securities mainframe-based trade processing systems, EDI) have yielded significant productivity benefits, even though they received little attention from many proponents of the "New Economy." Generally speaking, the most successful applications of IT appear to have been industry-specific ones, with direct impact on the core activities of the industry, as opposed to support activities.

Cyclical demand factors: Consumer behavior and stock market bubble

Buoyant financial markets and high consumer confidence in the late 1990s affected the productivity of the securities, retail, and wholesale sectors. These cyclical factors were the second most important cause of the 1995-99 productivity growth jump.

- ¶ A significant portion of the securities productivity growth jump was attributable to the irrational exuberance of retail on-line traders (which boosted trading volumes), surges in investment banking deal value and volume, and a jump in the growth of assets under portfolio management by mutual funds. Each of these factors stemmed in part from the buoyant performance of financial markets (especially the NASDAQ) during the period in question (Exhibit 18). The surge in industry outputs (e.g., trading volume and assets under management) did not require commensurate increases in labor inputs for two reasons. First, automation of processes allowed a significant portion of the labor force to be fixed. Second, while higher value transactions did not impact the physical activities performed by traders, bankers, and portfolio managers, they did increase the industry's output, as they corresponded with larger benefits derived by consumers.

- ¶ In the latter part of the 1990s, American consumers upgraded their purchases to higher-value products within the same product categories at a markedly accelerated pace (and within the same store format). This acceleration affected retail GMS sales and contributed significantly to the productivity growth jump in GMS (Exhibit 19). Operationally, the acceleration in productivity stemmed from the fact that selling a higher-value shirt rather than a less expensive one did not require significant

[11] Labor economies of scale existed because a significant portion of the labor is fixed with respect to usage

incremental labor within the same store format. This change in the American consumer's behavior does not appear to have been significantly induced by retailers' actions[12] and was not IT-enabled. On the other hand, demand-related factors such as increasing incomes (due to higher productivity growth in the rest of the economy), increased wealth, and increased consumer confidence must have contributed to this effect. The substitution to higher-value goods also occurred elsewhere in the retail and wholesale trades.

* * *

Our findings suggest that both structural and cyclical elements contributed to the 1995-99 productivity growth jump, and that structural factors figured most prominently. Of the structural factors, innovation (product, service, and process) and, to a lesser degree, regulatory change played a key role in bringing about US productivity acceleration. Heightened competitive intensity was a crucial catalyst in many sectors responsible for the aggregate productivity acceleration (Exhibit 20).

As we have seen, the application of IT played a role in the productivity acceleration of several of the six sectors. Given the amount of attention IT has received in many explanations of late-1990s productivity performance, we have devoted the remainder of this chapter to a more detailed appraisal of IT. The discussion that follows builds on our findings about the complex role of IT in the six jumping sectors to develop a more comprehensive and nuanced perspective on the relationship between IT and productivity growth.

---

12 According to retail industry experts and suggested by the wide-ranging effect across the majority of product categories studied (within or outside GMS).

APPRAISING THE CONTRIBUTION OF IT TO PRODUCTIVITY GROWTH

Many observers have linked two trends – the simultaneous surges in US productivity growth and IT investment – and concluded that IT caused an increase in labor productivity throughout the economy.[13] Our results suggest that this conclusion is not sound.

The six jumping sectors and the rest of the economy each contributed to the IT intensity surge roughly in proportion to their respective shares of GDP (Exhibit 21). As we have seen, though, the six jumping sectors contributed disproportionately to productivity acceleration (Exhibit 9). The remaining 69 percent of the economy, despite contributing only 1 percent of the net productivity growth acceleration, generated 62 percent of the IT intensity acceleration. Moreover, within the six jumping sectors, diverse factors, some having little to do with IT, caused the 1995-99 productivity growth acceleration.

Given the discrepancy between these findings and the consensus view, we have devoted the remainder of this chapter to our conclusions about the role of IT. These conclusions emerged from study of the six jumping sectors, as well as three paradox sectors that invested heavily in IT but failed to boost productivity (hotels, retail banking, and long-distance data telephony). We focus first on what IT is not, and then move on to describe what we think IT is. During the 1995-99 period, IT was not a magic bullet causing widespread productivity rate increases – either within the jumping sectors, or in the rest of the economy, where total factor productivity growth was actually negative. Rather, IT seems to have been more similar to than different from other types of capital. In application, its impact was extremely diverse and complex.

---

[13] Louis Uchitelle of *The New York Times* summarized the perspective from the Federal Reserve Bank of Kansas City's annual symposium in Jackson Hole, whose focus was productivity and the information economy, writing that "Most [in attendance] expressed their confidence that the vast changes wrought by computer technology are providing a solid foundation for long-run prosperity." *The New York Times*, page 1, column 2, September 3, 2001.

What IT is not: magic bullet causing widespread productivity growth rate increases

In the economy beyond the six key contributing sectors, total factor productivity growth was negative, and the paradox sectors we studied suggest that neither negative factors nor measurement issues offset or masked a large positive contribution from IT. In the six sectors that contributed most to US productivity acceleration, IT was important but only part of the story. Finally, our analysis of the nature of the economy-wide 1995-99 IT intensity surge suggests that it resulted from a number of unusual factors (i.e., Y2K, the emergence of the Internet, the rapid pace of PC upgrades, and surging investment in communications equipment). To a large extent, the simultaneous occurrence of these unusual factors and the productivity growth jump was coincidental.

¶ **Evidence from the economy beyond the six key sectors.** Total factor productivity (TFP) represents improvements in labor productivity above the historical contribution of capital investment. TFP for the economy as a whole was positive during 1995-99, and this fact has been cited as evidence that the application of IT was the key to the post-1995 productivity growth acceleration. (See “Objectives and approach” chapter for details.) However, TFP growth for the 70 percent of the economy outside of the six jumping sectors was -0.3 percent during the 1995-99 period (as opposed to +0.4 percent for 1987-95).[14] (Exhibit 22.) This means that outside of the six jumping sectors, IT capital generated productivity returns similar, at best, to other forms of capital. Such a finding is broadly consistent with our conclusion that the application of IT was just one piece of the 1995-99 productivity puzzle in the jumping sectors.

Even though TFP growth was negative, IT could have contributed to productivity acceleration, but been offset by other factors. Its impact could also have been mismeasured by the official statistics. Our paradox cases, in which IT intensity accelerated while productivity growth slowed, provided an ideal laboratory in which to test whether this occurred. In fact, we found numerous, diverse operational and external factors that explained why IT had not led to faster productivity growth. We did not find that IT’s positive impact had been overwhelmed by unrelated factors, or that the measurement issues were sufficient to

---

[14] To calculate TFP, we have employed traditional growth accounting method using a five-year moving average for labor and capital shares. The BEA’s tangible wealth data series, on which our analysis relied, reflects recent shifts in capital from traditional, long-lived capital towards more short-lived capital such as IT equipment in calculations of capital stock. The five-year, moving average approach also captures a portion of this shift in the labor and capital shares. A full and complete accounting of the shift toward short-lived capital would yield TFP growth rates that are even lower than those reported here due to increased capital services. Another bias may be introduced by the fact that the depreciation schedules used by the BEA to compile this data series have not been updated since the early 1990s.

explain the paradox. These paradox case results, which are summarized in Exhibit 23 and described in more detail below, provide additional evidence that IT was not, during the 1995-99 period, serving as a magic bullet causing widespread productivity growth rate increases.

¶ **Evidence from the six key contributing sectors.** Our analysis of the six jumping sectors confirmed the important contribution of the *production* of IT (i.e., by the semiconductor and computer manufacturing industries) to the aggregate productivity acceleration. Together, these sectors accounted for roughly 20% of the aggregate productivity growth (0.29 percentage points out of 1.33 percentage points).[15] However, the rich tapestry of causal factors underlying the 1995-99 productivity growth jump indicates that the *application* of IT was only one of many forces at work.

The application of IT was certainly important. IT investment was a necessary, but not sufficient, condition for the productivity performance of several sectors (e.g., warehouse automation in wholesale; tailored EDI systems at Wal-Mart and its imitators in retail GMS) and had a more central role in others (i.e., back office automation and, to a lesser degree, the exploitation of the Internet in the securities sector; and digital telephony in the telecom sector). Interestingly, many IT solutions that were readily available prior to 1995 were critical contributors to the jump.[16] To the extent that a new, higher-productivity economy came into being after 1995, it was not due to the application of contemporaneous innovations made by the IT producing industries.

However, the diversity of operational factors that caused the 1995-99 productivity growth jump is striking. As noteworthy is the prominence of factors unrelated to IT (including improved organization of functions and tasks in wholesale distribution centers, retail GMS, and long-distance telecom; the business decision by Intel to shorten product life cycles; and the ability of computer assemblers, retailers, and wholesalers to pass through higher-value computers and goods with no attendant increase in labor). From an operational perspective, the 1995 productivity growth jump was far more than an IT story. Many other factors were necessary and, in some cases, the application of IT simply did not make a meaningful contribution to the productivity growth jump.

---

[15] This figure represents the contribution of the computer manufacturing (0.10 percentage points) and semiconductor (0.17 percentage points) industries, along with the impact on retail sector productivity of the passing-through of computers that are more valuable to consumers (0.02 percentage points). See the retail trade case study for details.

[16] Software available after 1995 for whose impact we searched in our case studies included the Internet, B2B, B2C, and ESCM. Hardware available after 1995 for whose impact we searched in our cases included digital mobile technology, fiber optics, and increased processing power.

¶ **Evidence from the nature of the IT intensity jump.** One explanation for IT's inability to generate universal productivity benefits may be the nature of the jump in IT intensity during 1995-99. The simultaneous existence of aggregate productivity and IT intensity growth jumps caused us to investigate what led the IT capital stock's growth rate to accelerate. Exhibits 24 and 25 summarize the results of that investigation. They reveal that unusual events, including the need for Y2K investment, the emergence of the Internet, and the rapid pace at which PCs were upgraded from 1995 to 1999, caused significant IT investment. Absent these extraordinary factors, the IT capital intensity growth rate would have increased from its 1987-95 rate of 6 percent to 9.2 percent, rather than to the actual 13.9 percent. Moreover, the amount of unusual investment is actually larger than these figures suggest. Of the remaining increase in the IT capital stock, communications equipment comprised a large portion (roughly $100 billion, or 20 percent of the addition to total IT capital stock).[17] A portion of this investment was attributable to the initial buildup of corporate networking infrastructure; this rate of investment was also unusual and unlikely to be sustained.[18]

The magnitude of these unusual events suggests that the simultaneous occurrence of productivity growth and IT intensity jumps was somewhat coincidental. (Of course, this coincidence excludes the IT producing industries, who benefited from a direct link between IT investment and measured productivity.) It also holds a hopeful implication for the future: The United States now has a highly connected, standard IT infrastructure in place on which the IT producing industries can build new applications to generate future productivity benefits without large, commensurate increases in the IT capital stock.

This evidence about the six key sectors, the rest of the economy, and the nature of the IT intensity jump should not imply that IT does not contribute to productivity growth. Rather, it simply emphasizes that a robust explanation of the 1995 productivity growth jump must take into account a diverse set of factors beyond the role of IT. Even if IT was not the core explanation for the 1995 productivity acceleration, understanding the nature of its diverse impact and the reasons for this diversity is important – both for users of IT and for the IT producing industries

---

[17] This figure, like all those in Exhibit 17, is in chained 1996 dollars. Exhibit 17 can only be an approximation because of the complexities associated with manipulating Fisher aggregated capital stock data.

[18] The highly aggregated nature of the BEA's IT capital stock data have made it difficult for us to determine the exact portion of the communications IT capital stock surge attributable to unusual networking investments. If all communications equipment investments had been unusual, then the rate of IT intensity increase absent all extraordinary factors would have been 6.2 percent between 1995 and 1999 – nearly identical to the 6 percent 1987-95 rate. Of course, not all of the communications investments were unusual, so the 1995-99 rate of IT intensity growth absent unusual factors would likely have been somewhere between 6.2 percent and 9.2 percent.

themselves. The discussion that follows examines and seeks to explain the range of impact IT had in the sectors we studied.

What IT is: similar to other forms of capital, with diverse and complex impact in application

Our case studies indicate that the impact of applying IT varies from quite high in select, special instances, to virtually nonexistent in others. The nature of the industry to which IT is applied and the nature of the investment itself determine its productivity impact. Taken together, our jumping sector and paradox case studies suggest four potential results from IT investments.[19]

In some instances, IT offers clear, productivity-enhancing benefits.

- ¶ **IT can deliver dramatic productivity results in select instances.** The impact of IT (including communications equipment) can be quite large when it creates a new product or service, or expands labor capacity by several orders of magnitude. The productivity growth jump of the mobile telecom sector after 1995 resulted, in part, from the widespread application of digital cellular equipment (which relied on new standards that allowed better use of the available spectrum). The cheaper, often higher-quality voice transmission that resulted helped to increase usage. The productivity growth jump of the securities industry in 1995 (and the retail banking sector in 1982),[20] were possible because investments in IT infrastructure created large amounts of capacity to process additional transactions without adding incremental labor.[21] In all of these cases, the product or service itself was particularly well-suited to IT because it was essentially intangible information that could be digitized.

  IT can be a necessary but not sufficient enabler of productivity growth. The appropriate application of IT to core processes can facilitate productivity growth, but in many cases IT needs help to generate results. As we have seen, business process changes were necessary components of the Wal-Mart business innovation. Without them, it would have been impossible to reap the full productivity benefits of inventory management, electronic data interchange, and scanning systems. The same was true in the case of warehouse distribution

---

19 We studied three sectors that experienced an increase in the rate of IT intensity growth for 1995-99 vs. 1987-95, while their productivity growth rates decelerated across the same two periods. The sectors were hotels, retail banking, and the long-distance data transmission portion of the telecom industry.

20 The retail banking sector experienced a large productivity growth spurt beginning in 1982. See appendix of retail banking case for details.

21 The investments were mainframe systems to automate back office functions in both industries, servers and Web interfaces to process on-line trades in the securities industry, and ATM machines in retail banking.

centers, where IT was necessary for exploiting the full potential of electromechanical material handling systems. In instances such as these, IT is simply one of many tools that creative managers need to employ to help improve their operations.

IT is better able to play this enabling role in some industries than in others. In the retail and wholesale industries, for example, significant opportunities to apply IT existed for many players in 1995, and firms' exploitation of them was actually able to move the national productivity needle. In the hotel industry, on the other hand, the labor force is heavily concentrated in occupations that either are not amenable to IT automation (e.g., room cleaning), or have already reaped many of the benefits of automation (e.g., front desk workers) (Exhibit 26).

In other circumstances, IT's impact on labor productivity may be minimal, but this need not mean the IT is wasted or that the decision to invest in it was misguided.

¶ **IT can yield disappointing returns when it is invested ahead of its time or in excess.** We regard as "ahead of their time" investments in IT whose ability to deliver benefits is simply unclear for a considerable period of time, and "in excess" those whose benefits are unlikely ever to be realized. Our case studies revealed several examples of investments on which the jury is certainly still out. Some may ultimately prove to have been excessive.

- For example, the retail banking industry has experienced disappointing results from Customer Relationship Management (CRM[22]) investments, incurred larger merger[23] integration costs, and suffered from complexity costs associated with complex bundling and pricing options (Exhibit 27). In addition, the retail banking industry bought an average of two PCs per employee between 1995 and 1999. Some of this computing power is not fully utilized and likely never will be (Exhibit 28). It is still possible, of course, that some of these investments will yield benefits in the future.
- Similarly, the hotel industry has collected significant amounts of customer data that it does not yet use, selectively employed revenue management applications whose impact has been limited, and incurred large merger integration costs. For example, the investments of some hotel chains in revenue management applications do not appear to have enabled them to gain significant differential pricing benefits (Exhibit 29). Industry participants report that large profits

[22] CRM is defined broadly as the management of customer interactions using customer data and information technology to increase the value and number of profitable customer relationships.

[23] Facilitated by deregulation

and limited competitive intensity in major urban markets may have diverted management attention from productivity resulting in low impact IT investments (Exhibit 30).[24] Again, though, there is still potential that some of these investments will yield greater benefits in the future than they have to date.

- A third example is the long-distance sector of the telecom industry, which has made enormous investments in metro and long-haul networks that are currently underutilized and are likely to remain so for several years to come. The provision of easy capital (combined with new technology and forecasts of rapid demand growth) contributed to this excess network investment.

With the benefit of hindsight, some of the investments described above may have been mistakes. However, given the relative youth of IT capital and the resulting uncertainty around its benefits and costs, it is difficult to make a case that poor decision-making or irrationality has driven a significant portion of IT investment in the US.

¶ **IT can deliver productivity benefits that are unmeasured.** Consumer convenience associated with certain types of IT is not captured by our or other conventional productivity measures. Our paradox cases provided two examples of these measurement issues, which were by themselves not enough to explain the IT paradox.[25]

In the hotel industry, consumers may have benefited from costly property management and central reservation system upgrades. Immediate reservation capabilities, made possible by this investment, present potential guests with more accurate information on room rates and availability and make searching for and booking rooms on-line possible. The BLS' deflator for quality-adjusting hotel room prices, which only takes property characteristics into account, cannot capture such improvements in sales channels.[26] In retail banking, on-line banking transactions may be more convenient than conventional transactions. However, our analysis suggests that even if it were possible to adjust for this convenience, it would not cause banking productivity to accelerate (Exhibit 31). Overall, while there are certainly instances of marginal convenience that is not captured in our or any other output measures, our case studies suggest it is insufficient to explain a paradox of accelerating IT intensity growth coupled with decelerating productivity growth.

---

[24] Surging demand in major urban markets, coupled with some restrictions on the supply of new hotels (long construction lead terms, the risks inherent to building new hotels at the peak of real estate market valuations, and complex permitting processes) allowed hoteliers in these markets to earn large profits

[25] We recognize that measurement issues could also exist in other sectors.

[26] The BEA employs the deflator computed by the BLS.

The diversity and complexity of IT's impact suggests that for most industries, it is similar to other types of capital with respect to labor productivity. Firms invest in IT and obtain a return: in some instances, IT yields extremely favorable results; in others, its impact is disappointing. IT's impact is the greatest when it actually is the product, or its application expands labor capacity by several orders of magnitude. More typically, IT increases productivity by enabling business innovation and process improvement, often by substituting capital for labor. In these circumstances, it seems to have its greatest impact when directed toward core operations with the greatest concentration of labor. Waste of IT is also possible, as is investment that simply fails to deliver. In short, IT is not a magic form of productivity-enhancing capital. Its impact depends upon how, rather than how much, firms decide to apply it.

APPENDIX: MEASUREMENT ERROR DID NOT AFFECT THE MEASURED ACCELERATION AND IT PARADOX

Throughout MGI's analysis of what drove the productivity acceleration, we have sought to learn whether measurement error could have affected our findings. We found the following:

¶ Measurement error did not contribute significantly to the productivity acceleration of any of the six major contributing sectors (Exhibit 7).

¶ There was evidence of misallocated productivity acceleration contribution in one, small sector: Holdings and other investment offices (SIC67). (See Measurement Appendix for details.)

- The holdings sector appeared upon initial analysis to be a major contributing industry, ahead of telecom.
- Detailed analysis of the sector revealed that its performance was probably attributable to classification improvements made by the IRS to business receipts driving the sector's gross output figures.
- Any misclassification was small and distributed fairly evenly across the rest of the economy, so that it had no impact on the economy-wide productivity growth jump or the relative performance of other sectors of the economy.

¶ BEA uses the computer output deflator estimated by the BLS using a hedonic regression, which takes into account changes in the microprocessor speed, memory size, hard disk size, video memory size, audio capabilities, modem/networking capabilities, warranty, and other characteristics. The BLS methodology reflects the latest research in this area by both academic and government economists, and there was not a change or break in their methodology between the two periods.

¶ We did find some minor measurement issues in several sectors (See case study appendices. A separate measurement appendix also provides details on software measurement and issues in retail trade, wholesale trade, motor vehicle manufacturing, securities, telecom, and retail banking.) However, these issues did not dramatically affect our findings, especially on a delta basis (i.e., in assessing changes in growth rates across the 1987-95 and 1995-99 periods).

CONFIDENTIAL

Synthesis Exhibits

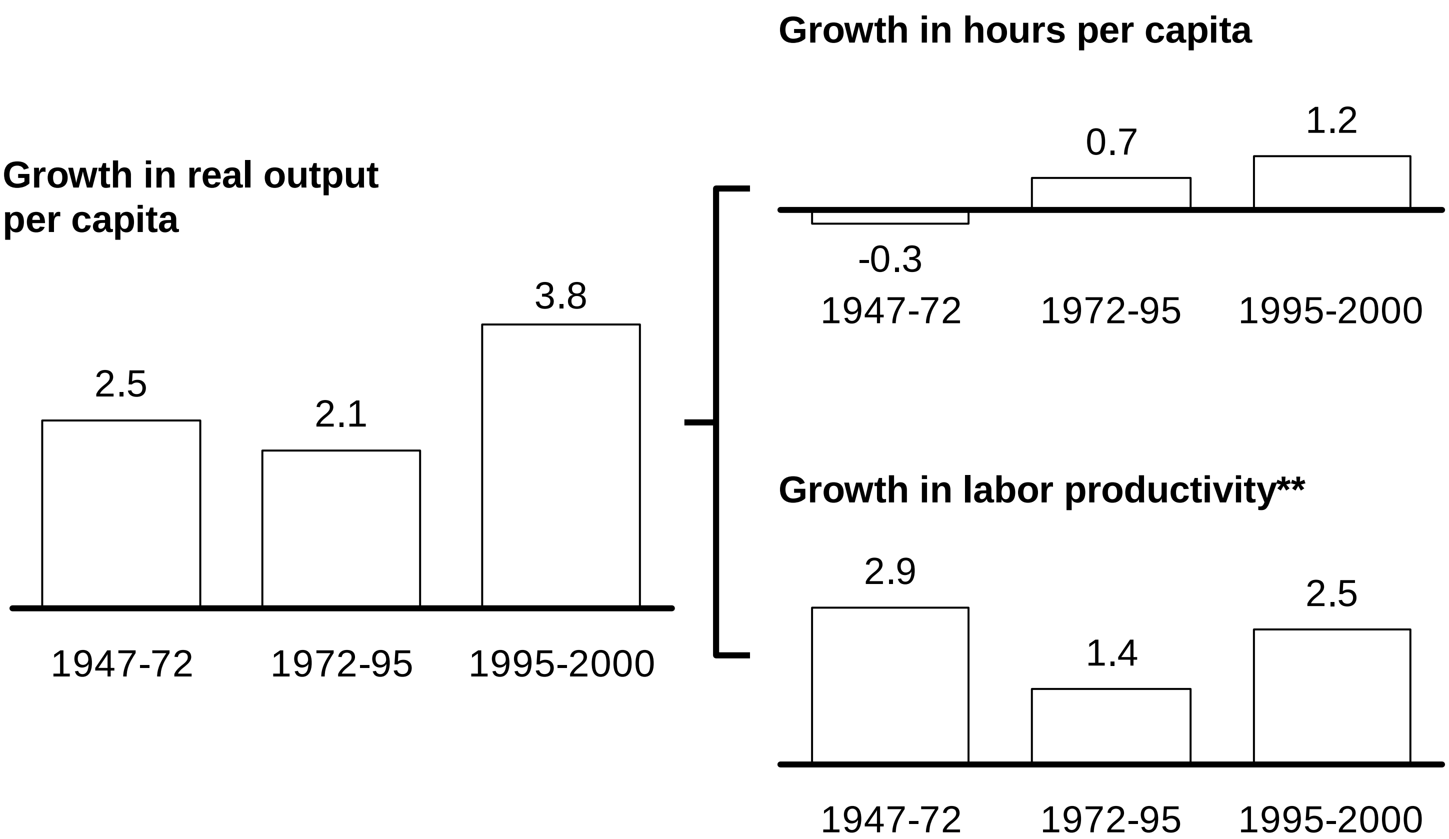
MGI/HIGH TECH PRACTICE NEW ECONOMY STUDY

October 10, 2001

Exhibit 1

OUTPUT PER CAPITA GROWTH OF NON-FARM BUSINESS*

CAGR, percent



* Excludes output of farms and government

** Labor productivity is defined here as output per hour worked

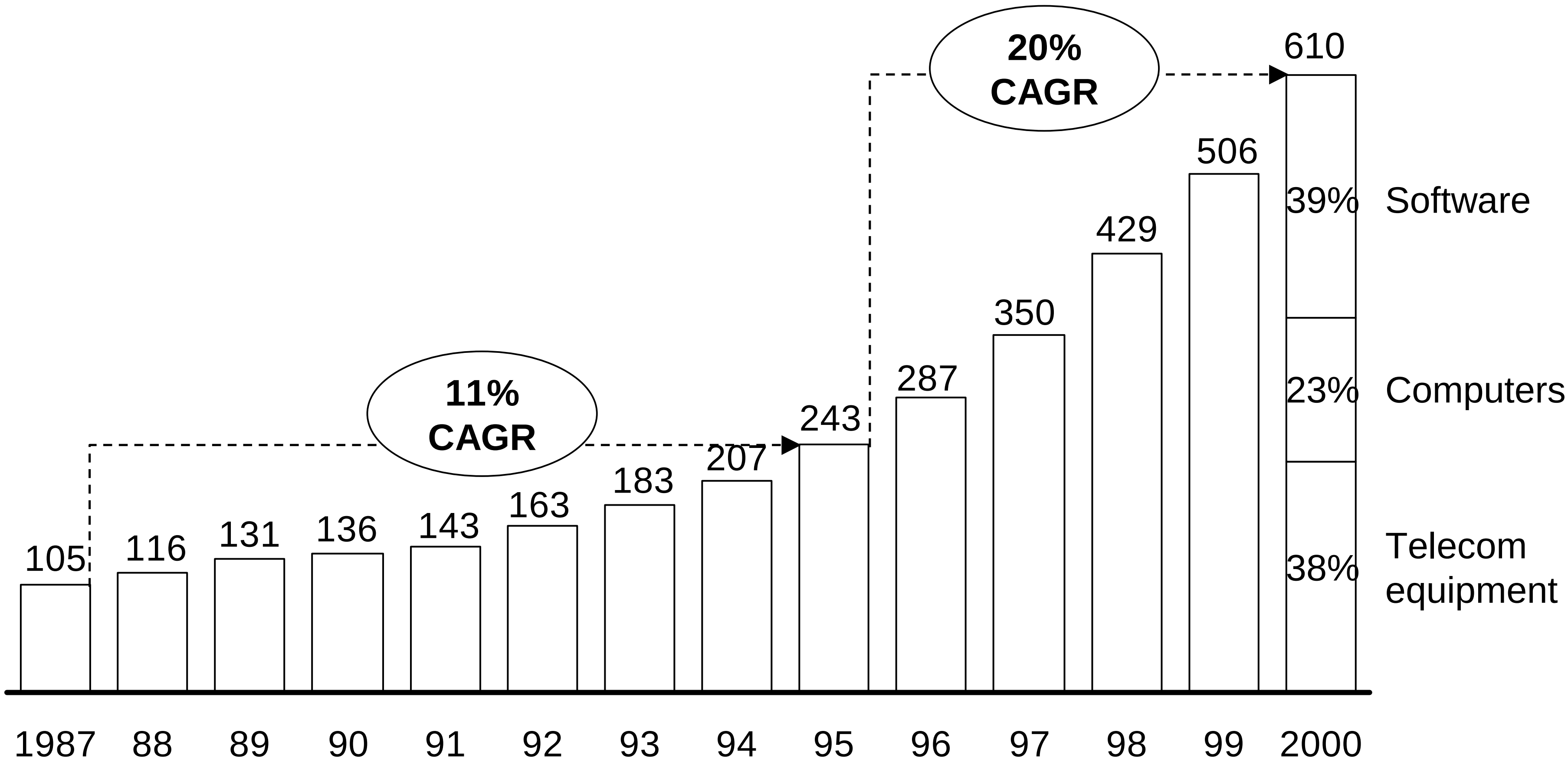
Source: BLS

Exhibit 2

REAL IT INVESTMENT GROWTH HAS ACCELERATED

Real IT investment*

1996 $ Billions



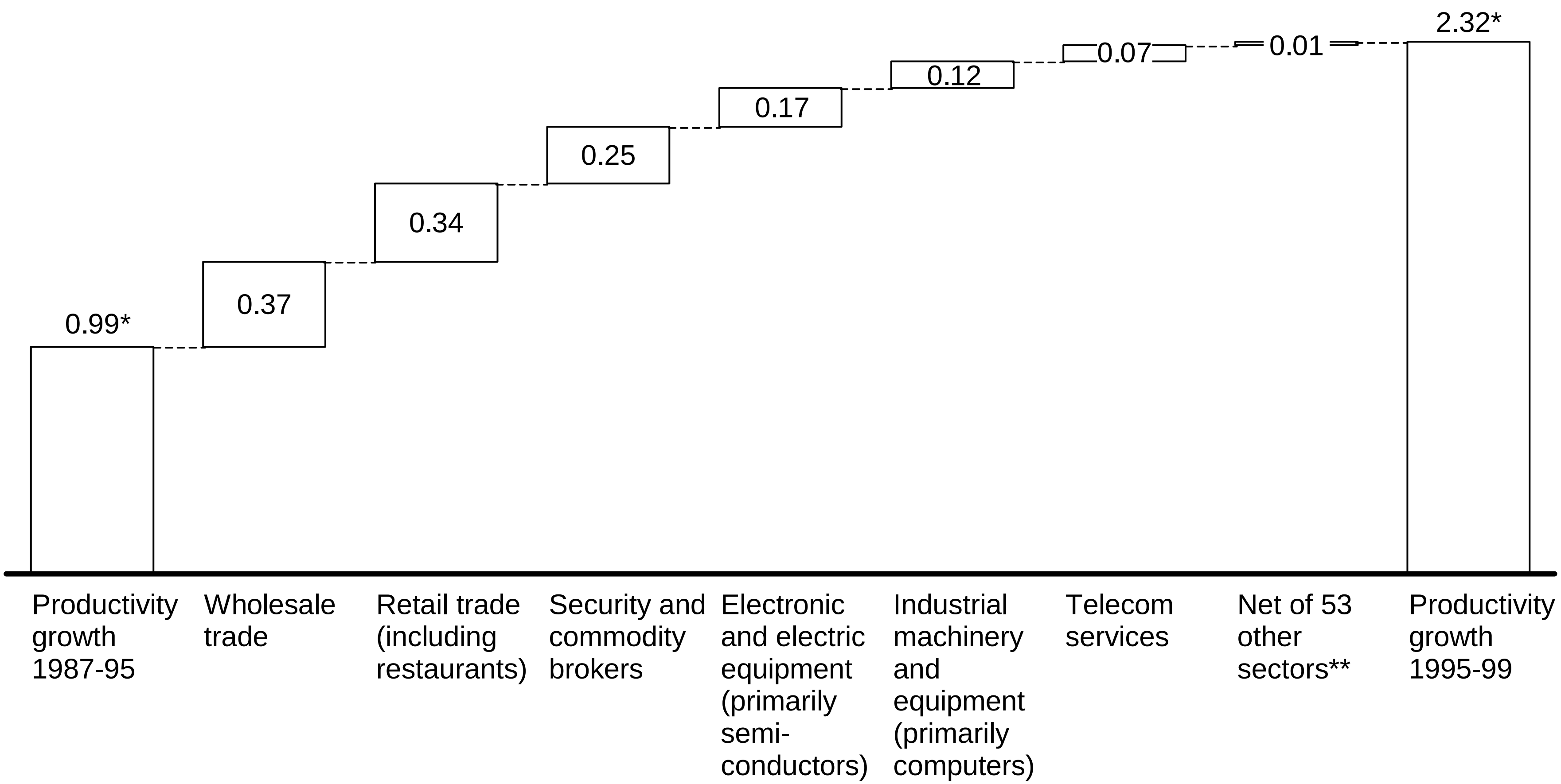
* BEA NIPA information processing equipment and software investment

Source: BEA; MGI analysis

Exhibit 3

CONTRIBUTION TO 1995 PRODUCTIVITY ACCELERATION

CAGR*, percent



* Industry-level analysis relies upon BEA sector data, which differ slightly from the widely publicized BLS aggregate data shown in Exhibit 1

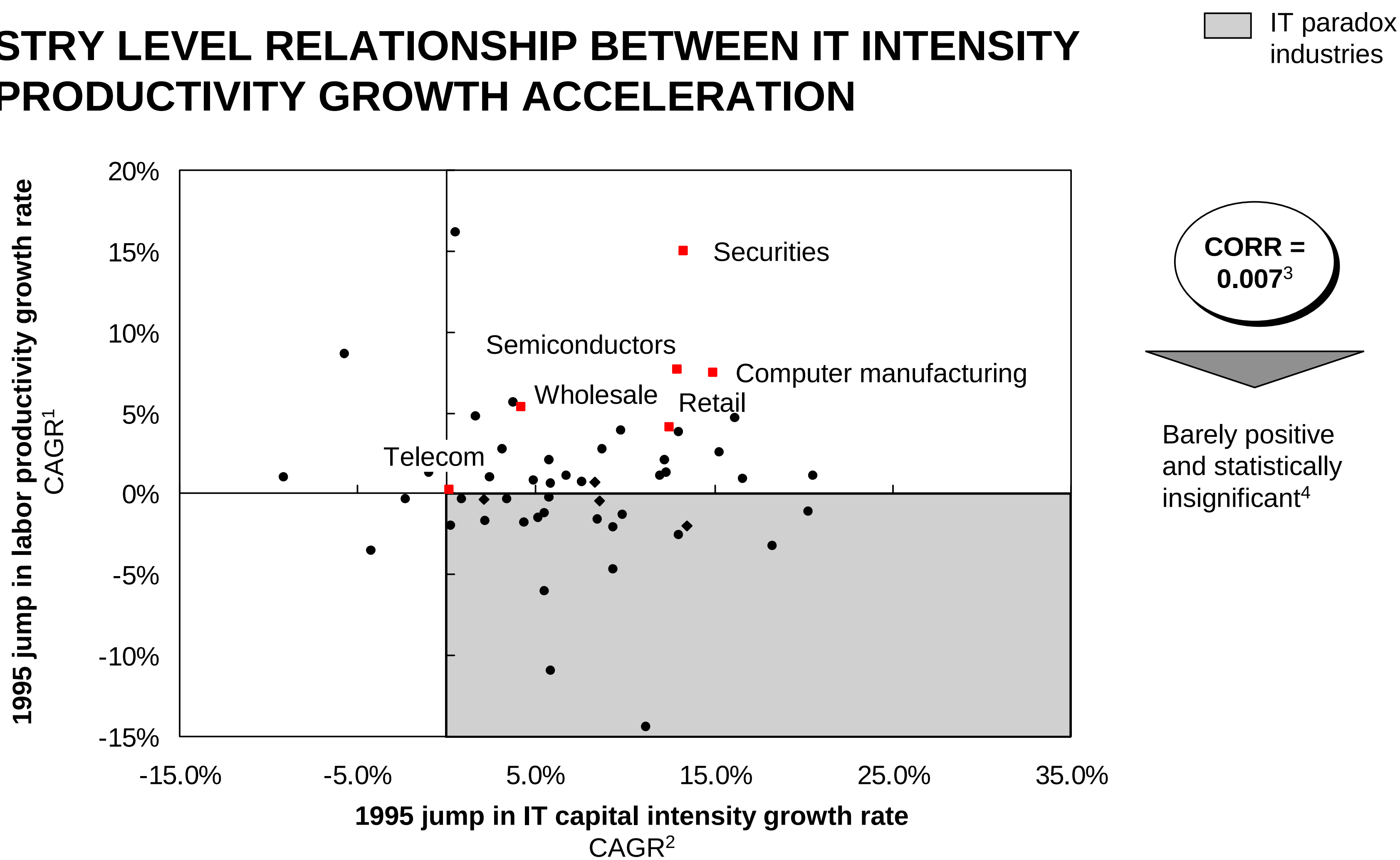
** 28 sectors made small positive contributions (totaling +0.47) and 25 sectors made small negative contributions (totaling -0.46)

Note: Holdings and other investment offices not classified as a jumping sector because of measurement issues. See appendix of Synthesis chapter and Measurement Appendix for details

Source: BEA; MGI analysis

Exhibit 4

INDUSTRY LEVEL RELATIONSHIP BETWEEN IT INTENSITY AND PRODUCTIVITY GROWTH ACCELERATION



1 Acceleration in real value added per PEP growth rate between 1987-95 and 1995-99

2 Acceleration in real IT capital stock per PEP growth rate between 1987-95 and 1995-99

3 Excludes farms, coal mining, and metal mining industries due to low initial levels of IT capital stock and holding companies for measurement reasons (see measurement appendix for details)

4 Although weighting each sector by its share of employment yields a statistically significant correlation of 0.26, even the weighted result becomes statistically insignificant if the 6 "jumping" sectors are excluded

Source: BEA; MGI analysis

Exhibit 5

Sectors studied

WE SELECTED A MIX OF "JUMPING" SECTORS AND "PARADOX" CASES

	No IT intensity increase	**IT intensity increase**
Productivity growth increase	"Non-IT story" cases • Lumber and wood products • Farms • Coal mining	"Jumping" sectors • Wholesale trade • Security and commodity brokers • Semiconductors • Computer manufacturing • Retail trade • Telecom (mobile and long-distance voice)
No productivity growth increase	"No story" cases • Construction • Trucking and warehousing • Insurance	"Paradox" cases • Retail banking • Hotel and lodging places • Telecom (long distance data)

Source: BEA; MGI analysis

Exhibit 6

CAUSALITY FRAMEWORK FOR JUMPING SECTORS

External factors	• Demand factors	• Macro-economic/financial markets, consumer preferences, etc.
	• Managerial and technological innovations	• Technological or managerial innovations, in own or related industry
	• Product market regulation	• Regulatory environment, government/agency policies
	• Up-/downstream industries	• Industry structure, changes in up-/downstream industries
	• Measurement issues	• Measurement issues causing a measured jump
Industry dynamics	• Competitive intensity	• Number of competitors, entries/exits, consolidation
	• Prices/demand effects	• Changes in prices and/or demand
Firm-level factors	• Output mix	• Mix shift between products/services with different productivity levels
	• Capital/technology/capacity	• Technology, capital/labor substitution, capacity creating investment
	• Intermediate inputs/technology	• More inputs, higher value/quality inputs (including embedded technology)
	• Labor skills	• Skills, training
	• Labor economies of scale	• Leverage of fixed labor
	• OFT/process design	• Organization of functions and tasks

Exhibit 7

OVERALL CAUSAL FRAMEWORK SUMMARY

		Semiconductors	Computer manufacturing	Telecomm (mobile)	Telecomm (long-distance voice)	Securities and brokers	Retail (GMS)	Wholesale (drugs)
External factors	• Demand factors (macro-economic/financial markets)	◑	◑	X	X	●	●	X
	• Business and technological innovations	◑	●	●	X	◑	●	●
	• Product market regulation	X	X	●	●	◑	X	X
	• Up-/down-stream industries	X	◑	X	X	X	X	◑
	• Measurement issues	X	X	X	X	X	X	X
Industry dynamics	• Competitive intensity	●	X	●	●	●	●	●
	• Prices/demand effects	X	X	●	X	●	X	X
Firm-level factors	• Output mix	●	●	X	X	X	X	X
	• Capital/technology/ capacity	◑	X	●	X	●	X	◑
	• Intermediate inputs/ technology	X	●	X	X	X	●	●
	• Labor skills	X	X	X	X	X	X	X
	• Labor economies of scale	◑	X	●	X	●	◑	X
	• OFT/process design	X	X	X	●	X	◑	◑

Source: MGI analysis

Exhibit 8

MGI COVERAGE OF MAJOR CONTRIBUTING SECTORS

Coverage	Sectors analyzed	Percent of GDP	Percent of employment	Contribution to productivity acceleration CAGR, percent: BEA total	Contribution to productivity acceleration CAGR, percent: MGI coverage	Comments
Complete or near-complete coverage	• Computer manufacturing*	0.77	0.07	0.12	0.10	• BEA contribution is for all industrial machinery and equipment; MGI is for computers only
	• Semi-conductors*	0.75	0.16	0.17	0.20	• BEA contribution is for all electronics; MGI is for semiconductors only
	• Telecom**	2.10	0.76	0.07	0.10	• MGI physical output measure accounts for differences; MGI contribution focus is on mobile and long distance
	• Securities	1.64	0.60	0.25	0.17	• MGI physical output measure and minor scope differences account for difference
	Subtotal	5.24	1.59	0.61	0.57	
Partial coverage	• Retail and restaurants	9.21	15.82	0.34	0.07	• BEA contribution is for retail and restaurants; MGI is for retail general merchandising (0.05) and the computer deflator's impact on retail through PC sales (0.02)
	• Wholesale	6.92	5.29	0.37	0.03	• BEA contribution is for all wholesale; MGI is for wholesale drugs
	Subtotal	16.13	21.11	0.71	0.10	
Targeted coverage	• Retail	–	–	–	0.24	• MGI has targeted coverage aimed at understanding the applicability of retail GMS and wholesale drug findings to the rest of their respective sectors
	• Wholesale	–	–	–	0.35	
	Subtotal	–	–	–	0.59	
	Total	**21.37**	**22.70**	**1.32**	**1.26**	

* From National Bureau of Economic Research

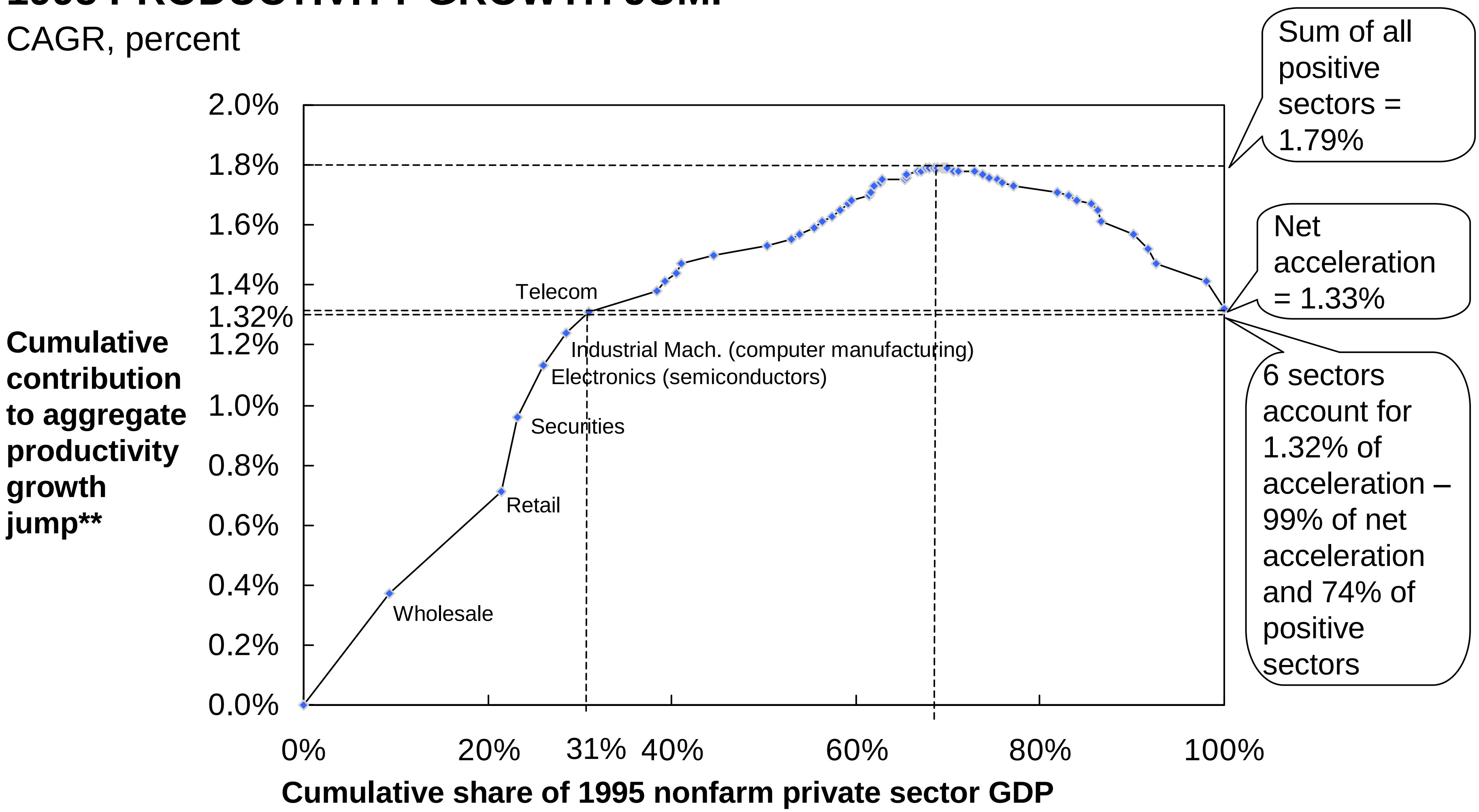
** Data for BEA "telephone and telegraph" sector

Source: BEA; MGI analysis

Exhibit 9

CUMULATIVE PRODUCTIVITY CONTRIBUTION DIAGRAM*: 1995 PRODUCTIVITY GROWTH JUMP

CAGR, percent



* Sunrise productivity diagram in Harberger, Arnold, "A Vision of the Growth Process," *AER*, Vol. 88, No.1 (1998)

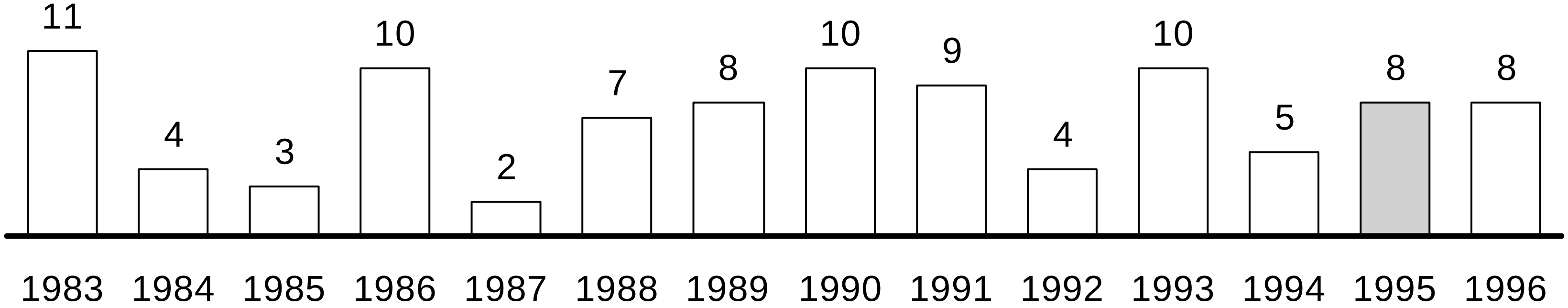
** Excludes contribution of farms and government; holding sector contribution distributed among all sectors other than top 6 contributors

Source: BEA; MGI analysis

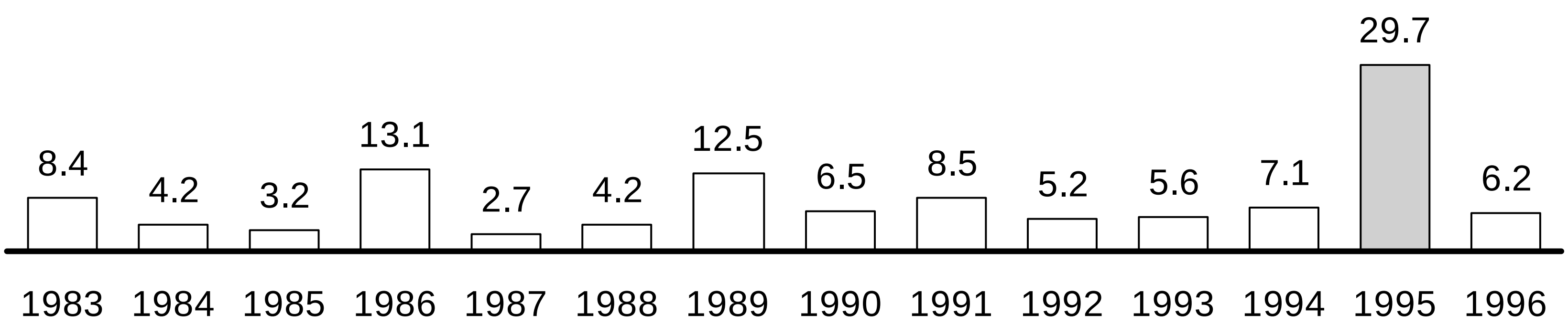
Exhibit 10

EMPLOYMENT IN "JUMPING" SECTORS WAS UNUSUAL IN 1995

Number of jumping sectors*



Share of employment in jumping sectors*
Percent share



* A sector is classified as "jumping" in year Y if its compounded annual growth rate of productivity for years Y through Y + 3 is at least 3% higher than it was for years Y - 3 to Y

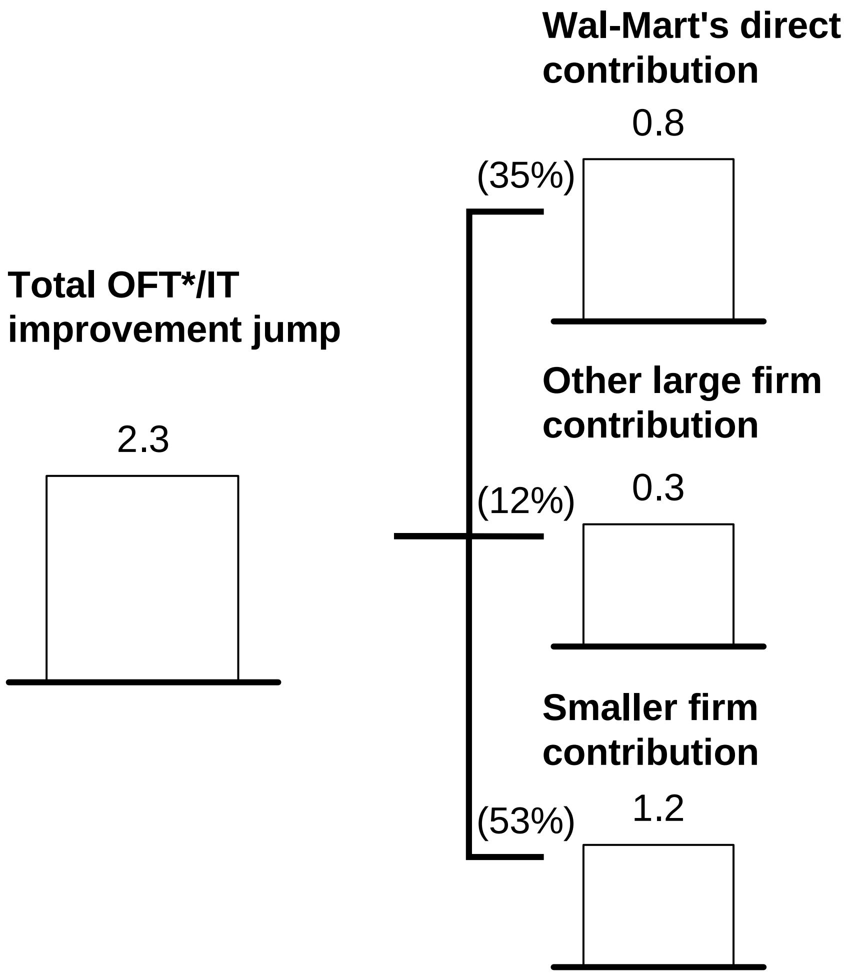
Source: BEA; MGI analysis

Exhibit 11

WAL-MART CONTRIBUTED DIRECTLY OR INDIRECTLY TO ALMOST ALL OF THE RETAIL GMS OFT*/IT IMPROVEMENT JUMP

Throughput acceleration, 1995-99

CAGR



- Contribution due to moderate improvement in throughput coupled with large size

- Turnaround at Sears
- Continued improvement at Target (explicit emulation of Wal-Mart) and K-Mart
- Partially offset by declines at Service Merchandise and Federated

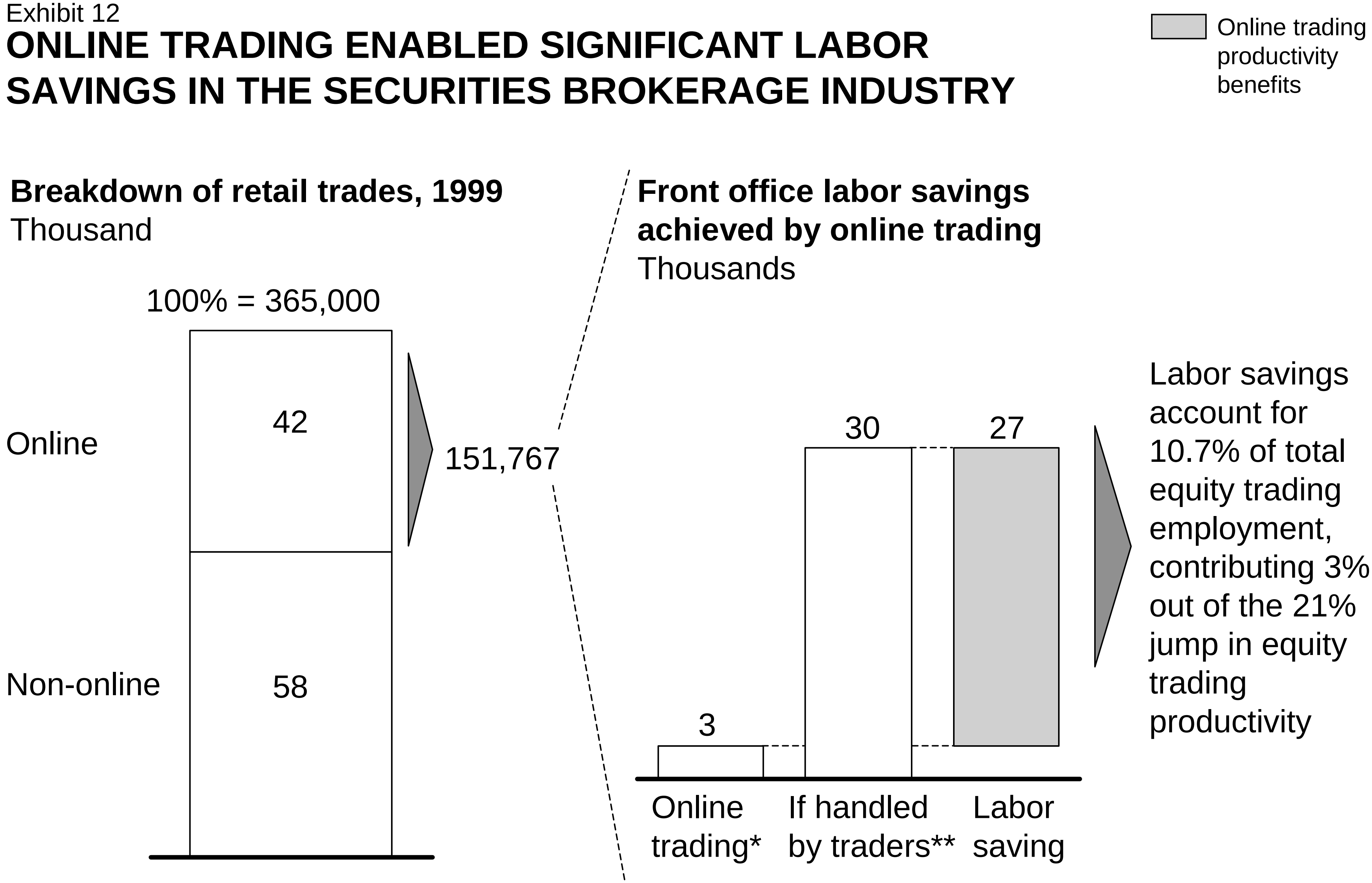
- Reaction to Wal-Mart leads to significant improvement in throughput
- Large improvements in throughput and increased size of Meijer

* OFT = Organization of Functions and Tasks; captures organizational improvements

Source: MGI analysis

Exhibit 12

ONLINE TRADING ENABLED SIGNIFICANT LABOR SAVINGS IN THE SECURITIES BROKERAGE INDUSTRY



* Includes Web-site administration, content editing, and additional IT staff

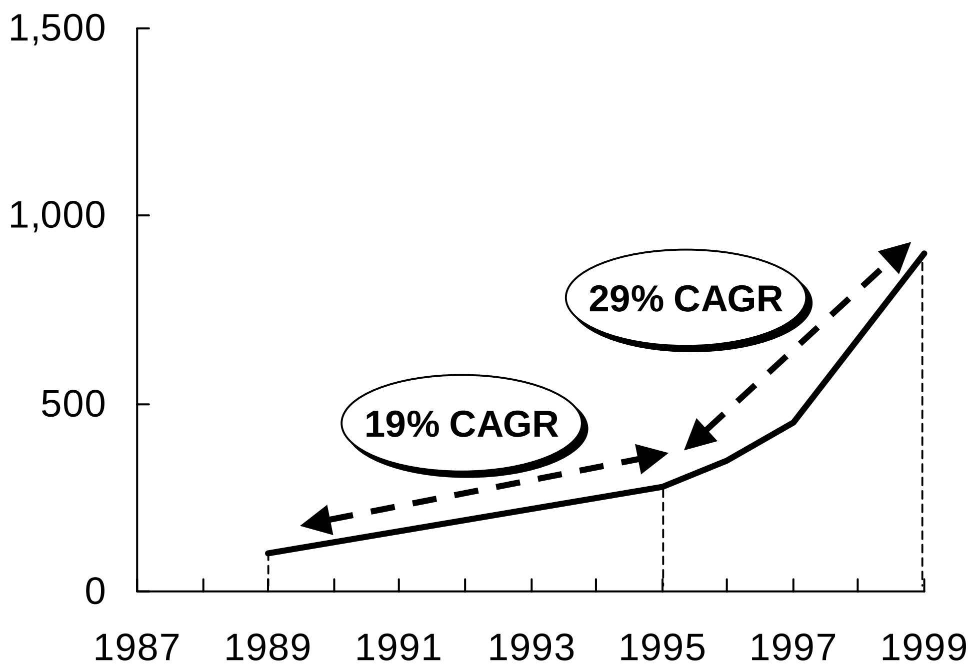
** Assumes average trader executes 20 trades per day

Source: Company reports; interviews; McKinsey analysis

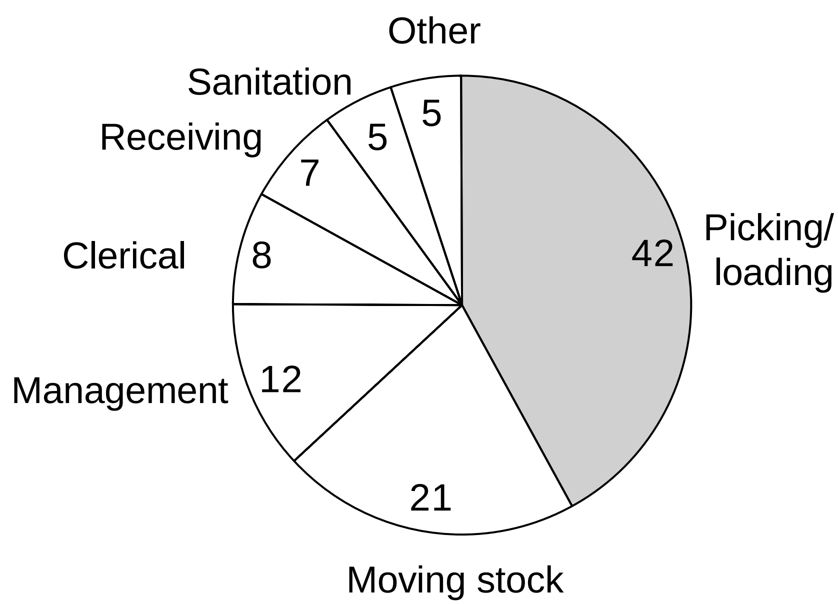
Exhibit 13

WAREHOUSE AUTOMATION REDUCED THE LARGEST LABOR COST CATEGORY

Warehouse management system sales
Nominal $ Millions



Distribution center labor
Percent



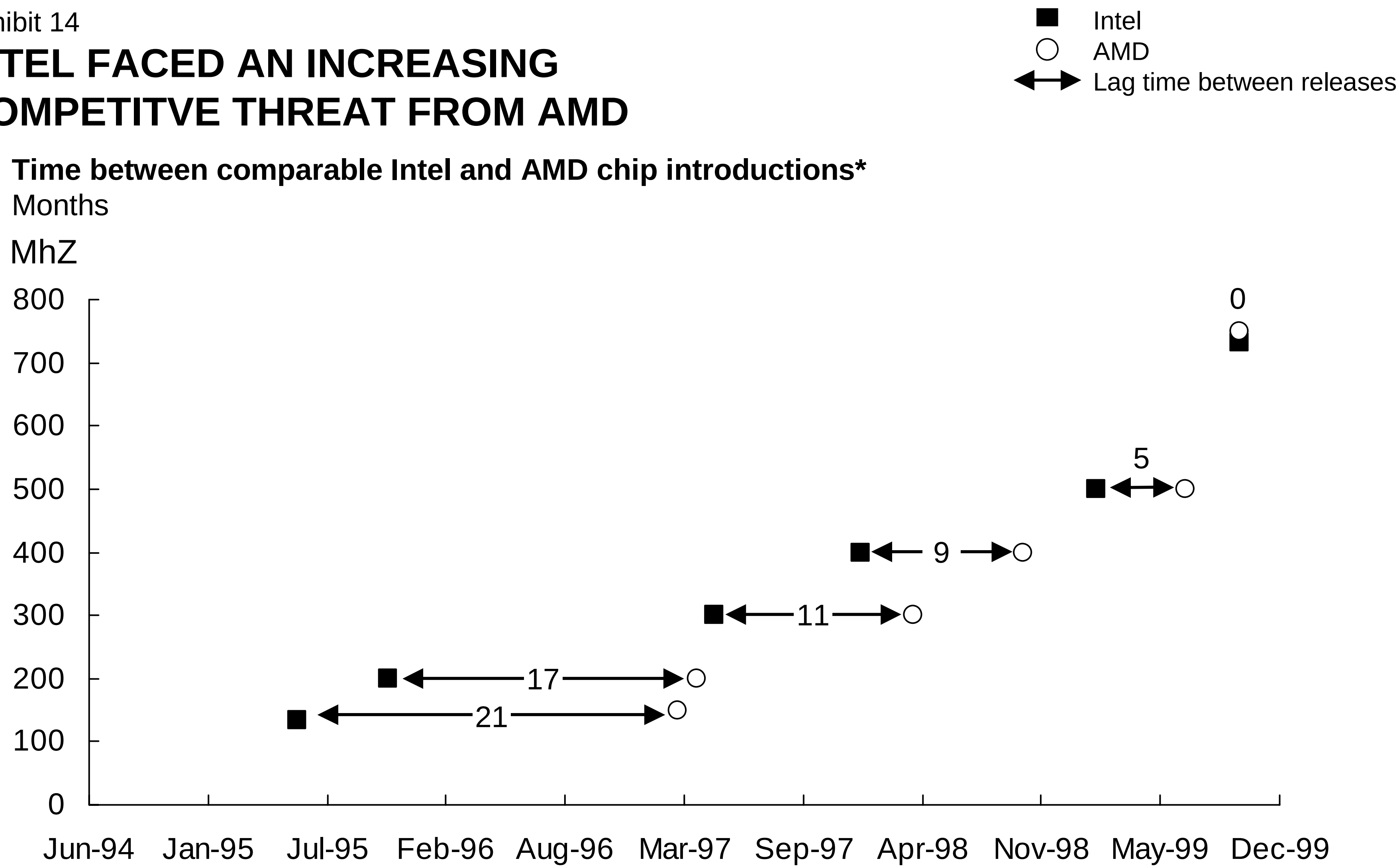
Source: AMR Research

Exhibit 14

INTEL FACED AN INCREASING COMPETITVE THREAT FROM AMD

Time between comparable Intel and AMD chip introductions*

Months

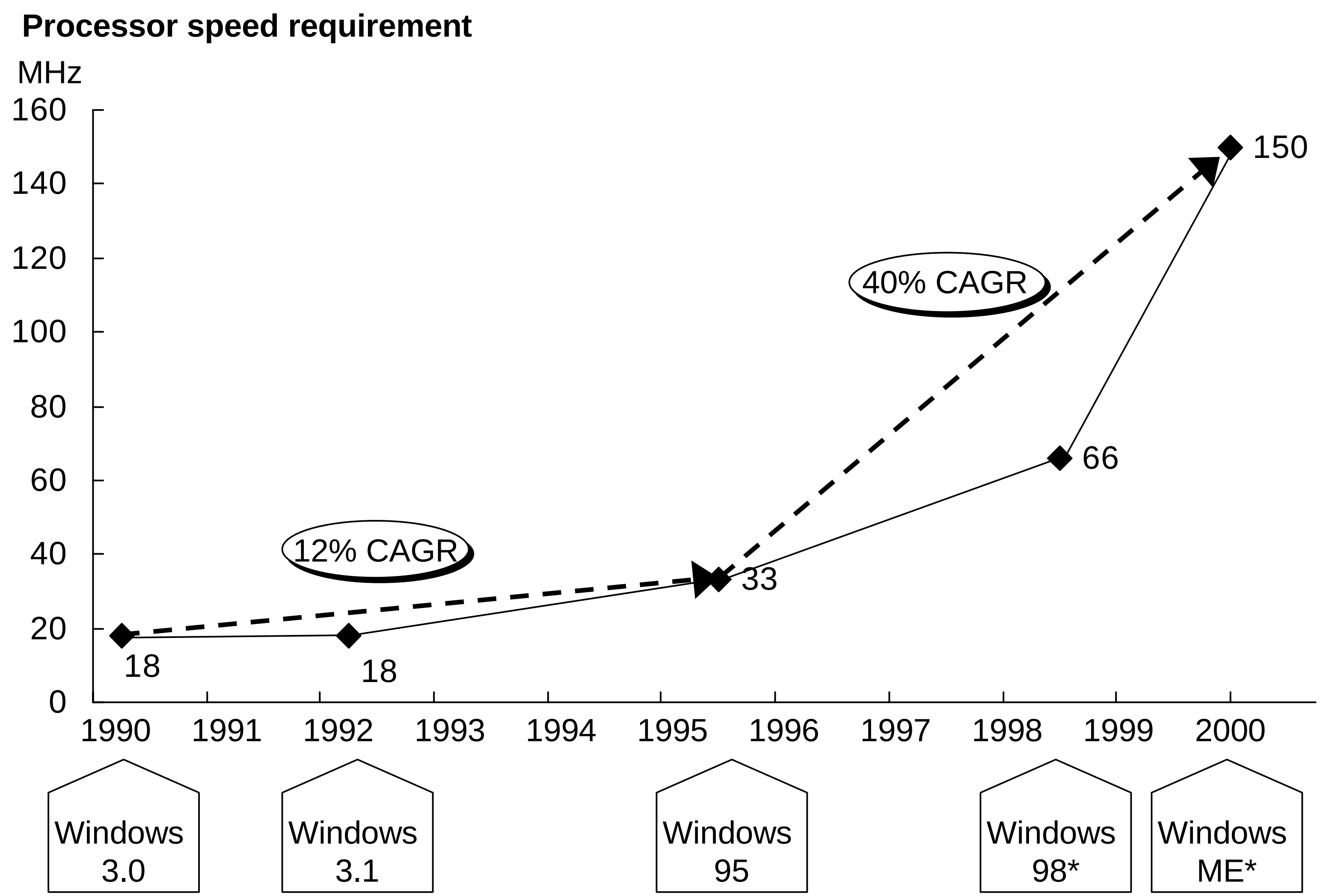


* Only includes releases most suitable to comparison, both companies released many more chips over the period

Source: Intel; Dataquest; Macinfo.de; MGI analysis

Exhibit 15

OPERATING SYSTEMS' PERFORMANCE REQUIREMENTS HAVE ACCELERATED



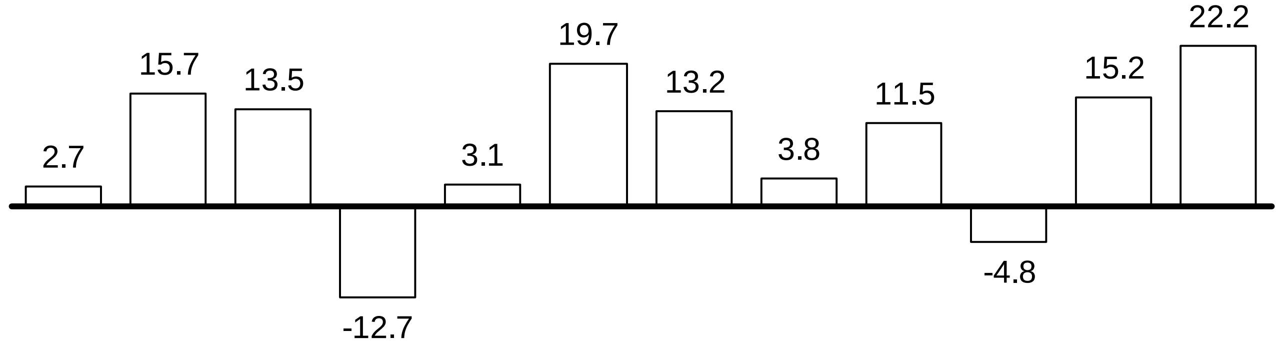
* Second edition

Source: Microsoft; Datapro; McKinsey analysis

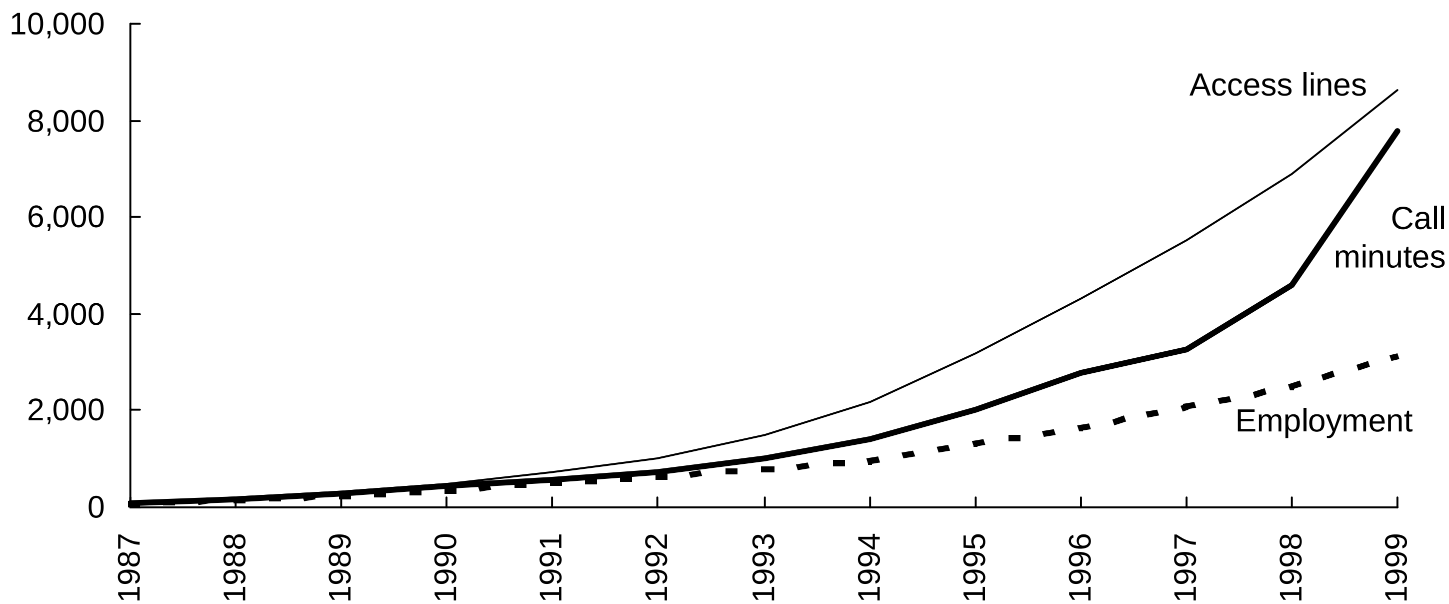
Exhibit 16

PRODUCTIVITY IN MOBILE TELECOM WAS DRIVEN BY RAPID INCREASES IN OUTPUT

Mobile service annual productivity growth
Percent



Mobile service output and input measures
Indexed, 1987 = 100

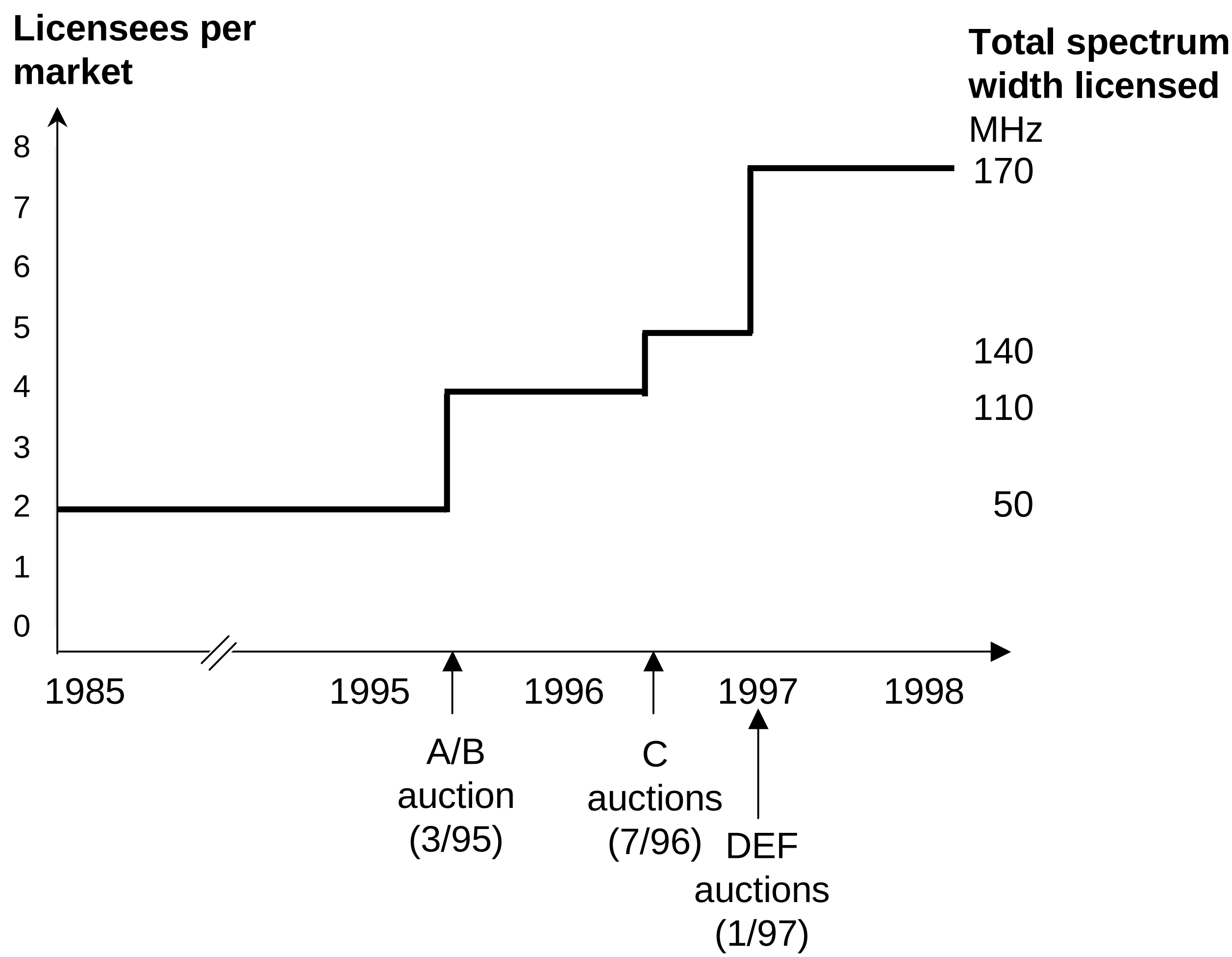


Source: FCC; MGI analysis

Exhibit 17

INCREASED CAPACITY CREATED BY GOVERNMENT AUCTIONS OF ADDITIONAL (PCS) SPECTRUM

Number of mobile services competitors per market in U.S., 1985-98

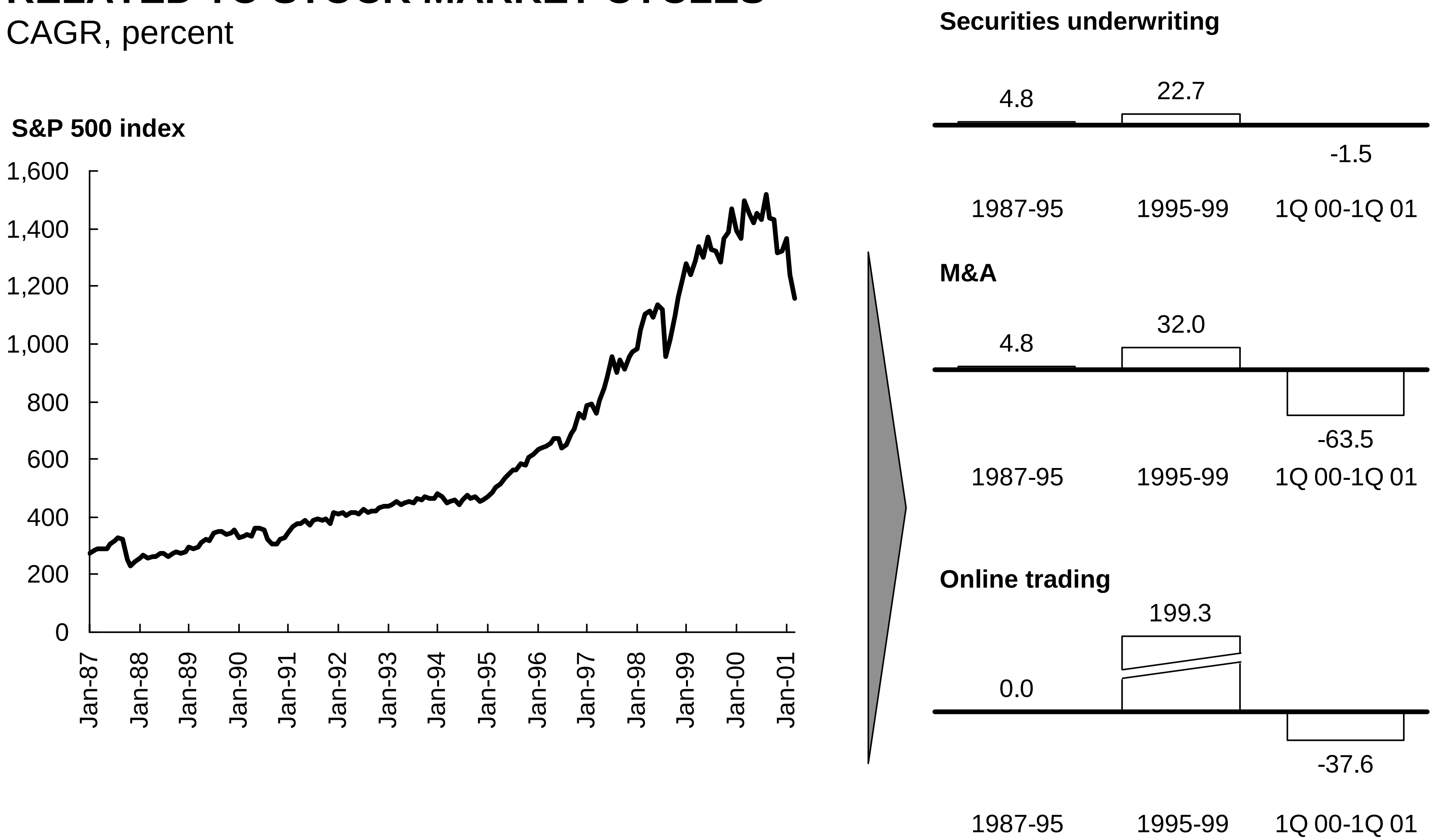


Source: NWRA; FCC; MGI analysis

Exhibit 18

SECURITIES INDUSTRY OUTPUT IS CLOSELY RELATED TO STOCK MARKET CYCLES

CAGR, percent

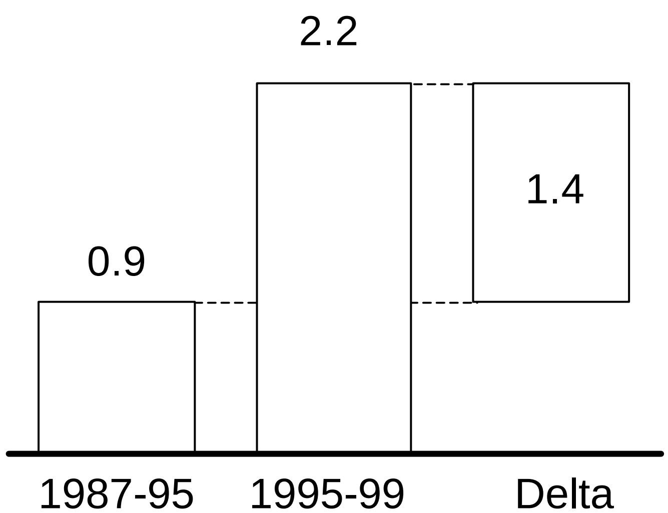


Source: SIA; ICI; SEC; NYSE; NASDAQ; MGI analysis

Exhibit 19

SUBSTITUTION TO HIGHER VALUE GOODS HAS CONTRIBUTED SIGNIFICANTLY TO THE THROUGHPUT GROWTH JUMP IN RETAIL GENERAL MERCHANDISE

Real contribution of substitution to higher value goods (within same format, at detailed category level)
Percent



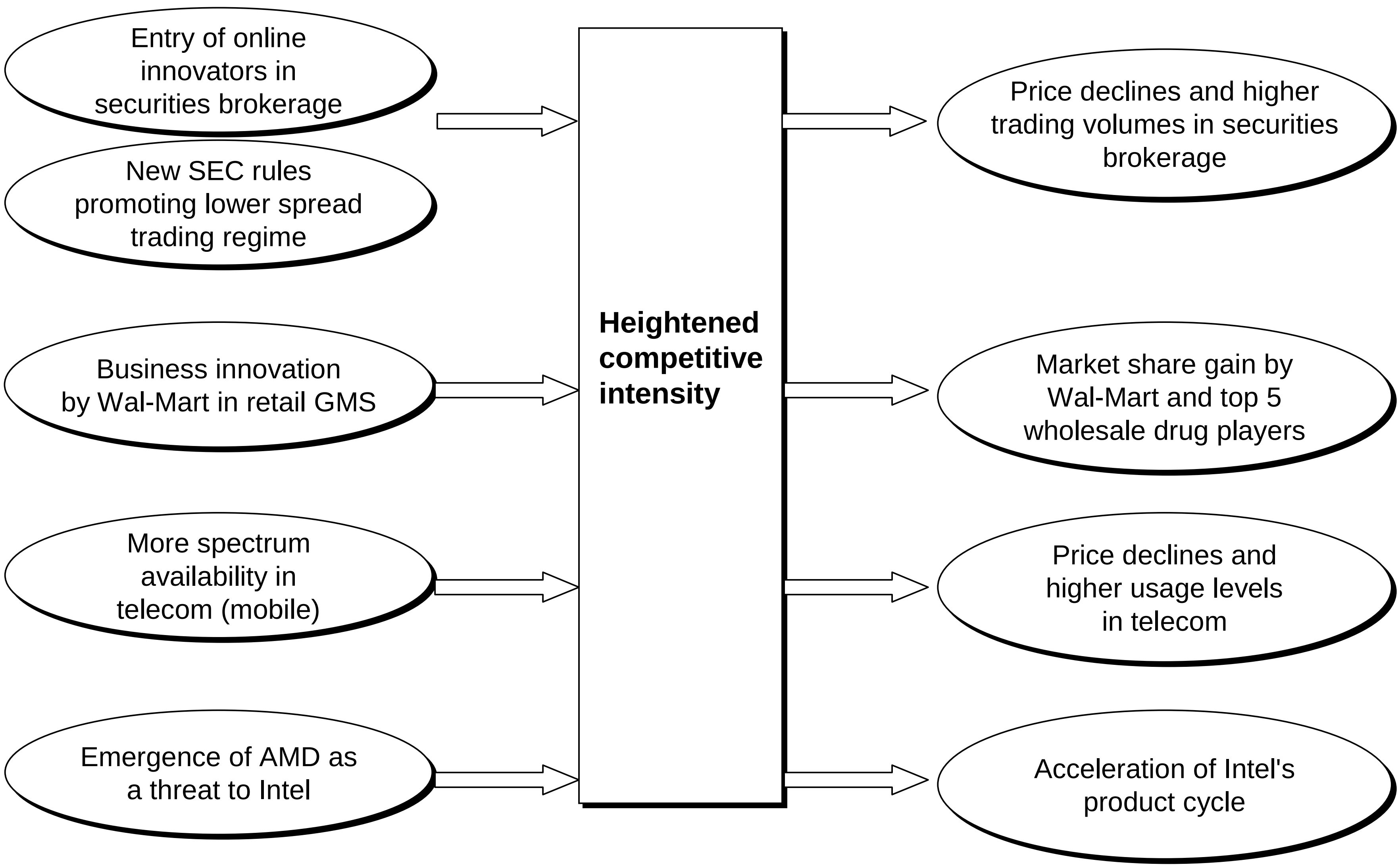
- Retailers have benefited from the pass-through of higher value consumer goods
- This effect contributes 1/3 (1.4%) of the 3.2% throughput growth jump in General Merchandise

Note: After adjusting for format mix shift (+0.27 and +0.21) and estimated formula bias in sales deflators (+0.40 and +0.40); numbers do not total due to rounding

Source: NPD; IRI; IMR; BEA; BLS; U.S. Census; MGI analysis

Exhibit 20

MANY OF THE EXTERNAL FACTORS DRIVING PRODUCTIVITY ACCELERATION ACTED THROUGH COMPETITIVE INTENSITY

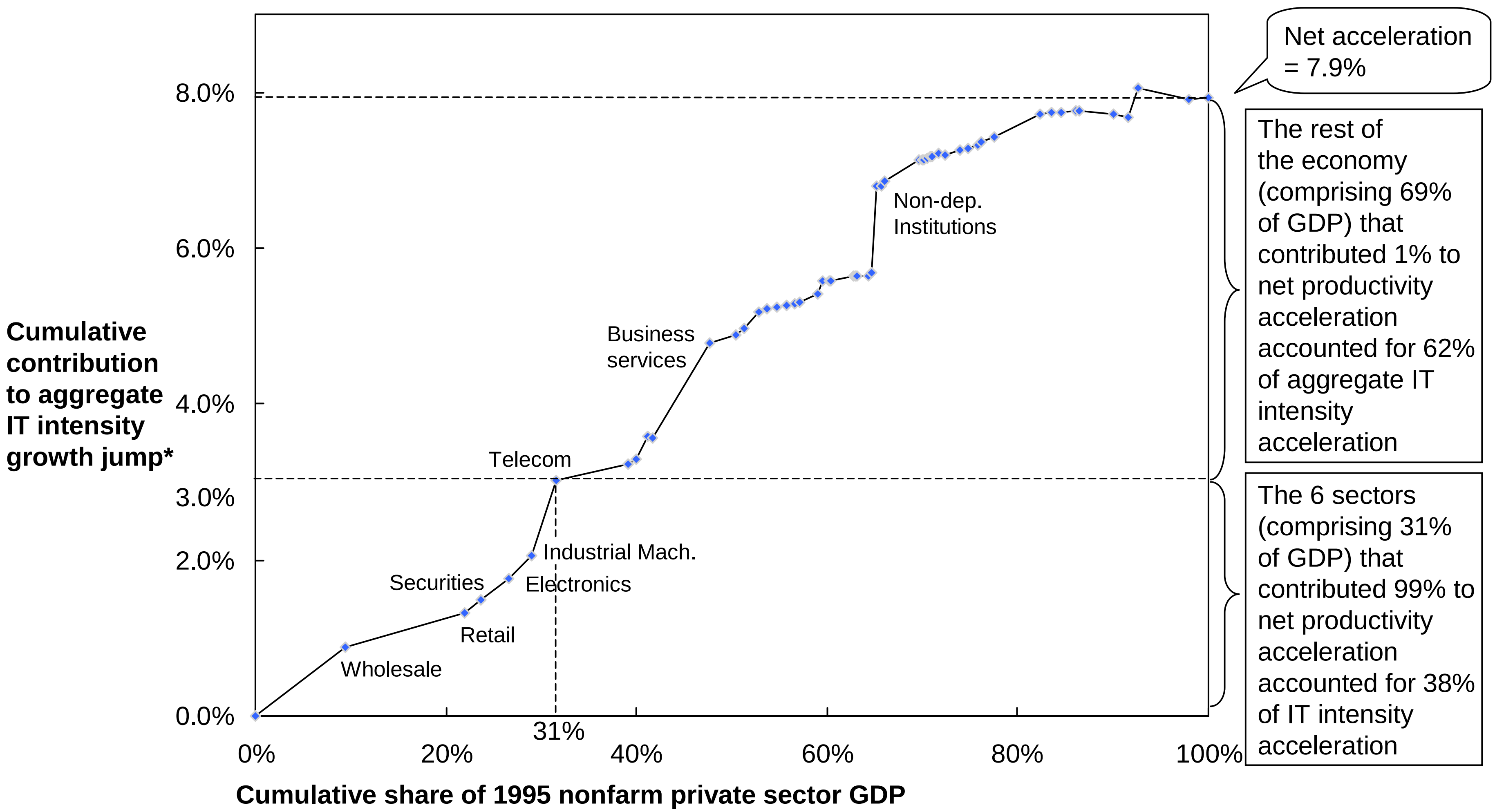


Source: MGI analysis

Exhibit 21

CUMULATIVE IT INTENSITY CONTRIBUTION DIAGRAM: 1995 IT INTENSITY GROWTH JUMP

CAGR, percent



* Excludes contribution of farms and government; holding sector contribution distributed among non top 6 sectors

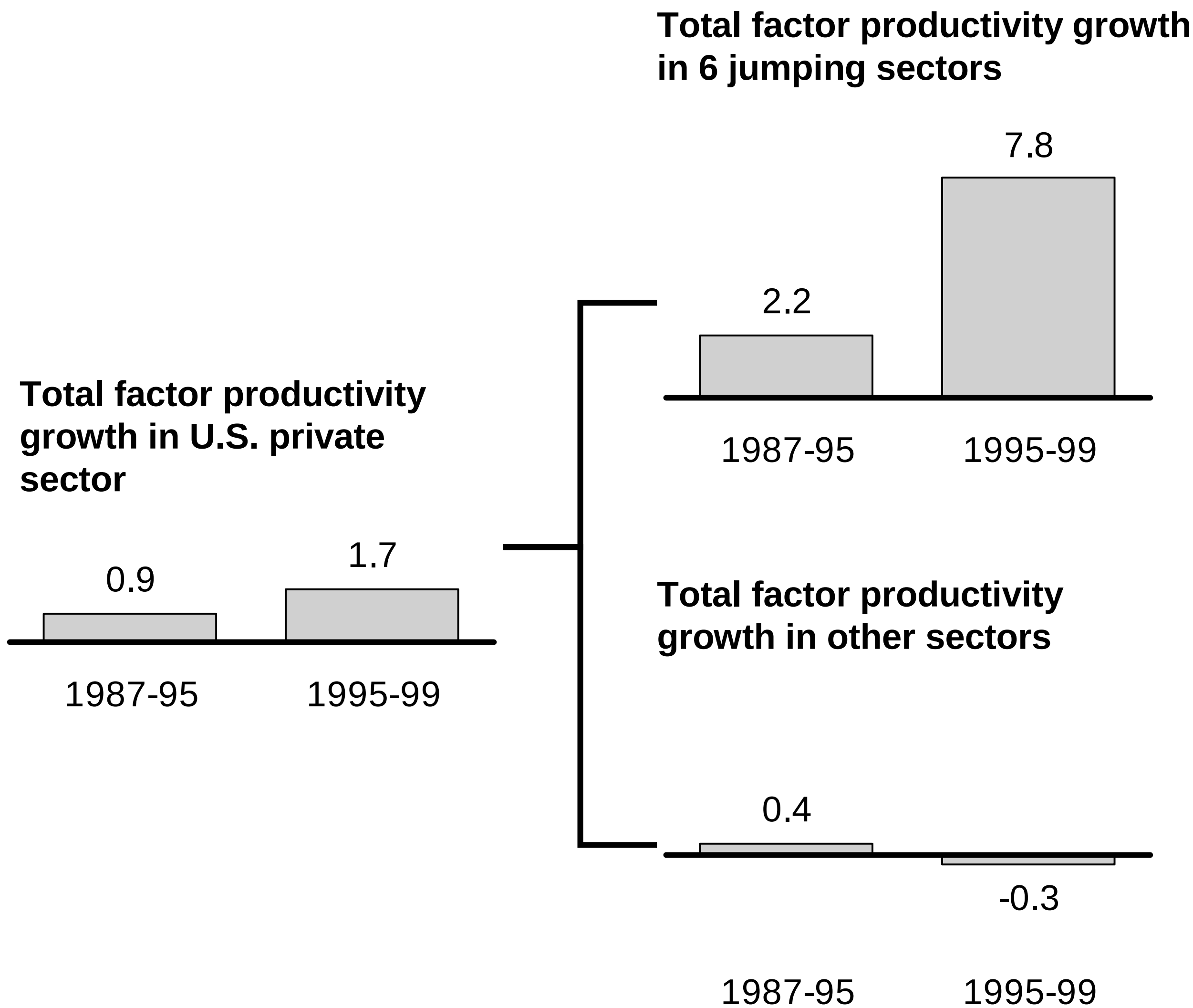
Source: BEA; MGI analysis

Exhibit 22

TOTAL FACTOR PRODUCTIVITY PERFORMANCE IN THE ECONOMY

Decomposition of TFP growth in 6 jumping sectors vs. rest of economy

CAGR



Source: BEA; MGI analysis

Exhibit 23

EXPLANATION FOR IT JUMPS NOT YIELDING PRODUCTIVITY JUMPS

● Important (>50% of investment)
◑ Somewhat important (10-50% of investment)
X Not important (<10% of investment)

		Hotels	Banking retail	Telecom (long-distance data)	
External factors	• Capital markets/ demand effects	◑	◑	◑	• **Hotels:** strong demand growth beyond hotels' supply response; **Retail banking:** high returns supported by noninterest income, driven, in part, by buoyant financial markets; **Telecom:** easy capital fuels investment*
	• Product market regulation	X	◑	◑	• **Retail banking:** lack of nationwide electronic payment system; interstate banking deregulation facilitated merger activity; **Telecom:** failure of 1996 Telecom Reform Act to create fully competitive local market
	• Y2K	◑	X	X	
	• Unmeasured consumer benefits	◑	◑	X	• **Hotels:** increased customer convenience not measured; **Retail banking:** full benefits of online banking, automated call centers difficult to measure
Industry dynamics	• Low competitive intensity	◑	◑	X*	• **Hotels:** high profitability and somewhat limited competitive intensity (especially in large urban markets) may have diverted management attention; **Retail banking:** industry becomes more concentrated, and more profitable
	• Lower than expected demand	X	X	◑	• **Telecom:** demand for DSL/broadband services not realized
Firm-level explanation for lack of productivity enhance-ment	• Unmeasured convenience to customers	◑	◑	X	• **Hotels:** real-time and online reservations made possible by costly PMS/CRS upgrades; **Retail banking:** "arms race" benefits consumers (e.g., online banking, call centers)
	• Y2K compliance	◑	X	X	• Necessary but not designed to enhance productivity
	• Software and hardware that did not yield expected returns	◑	◑	●	• **Hotels:** collection of data not yet used; revenue management; merger integration costs; **Retail banking:** disappointing CRM results to date; complexity costs associated with bundling/pricing options whose consumer benefits are unclear to date; merger integration costs; **Telecom:** disappointing to date, but may yield future benefits as data demand grows rapidly
	• Excessive/ unnecessary investment	X	◑	●	• **Retail banking:** PCs purchased likely excessive in number and power; **Telecom:** overly optimistic demand forecasts and cheap capital may have driven investment that was excessive and too early

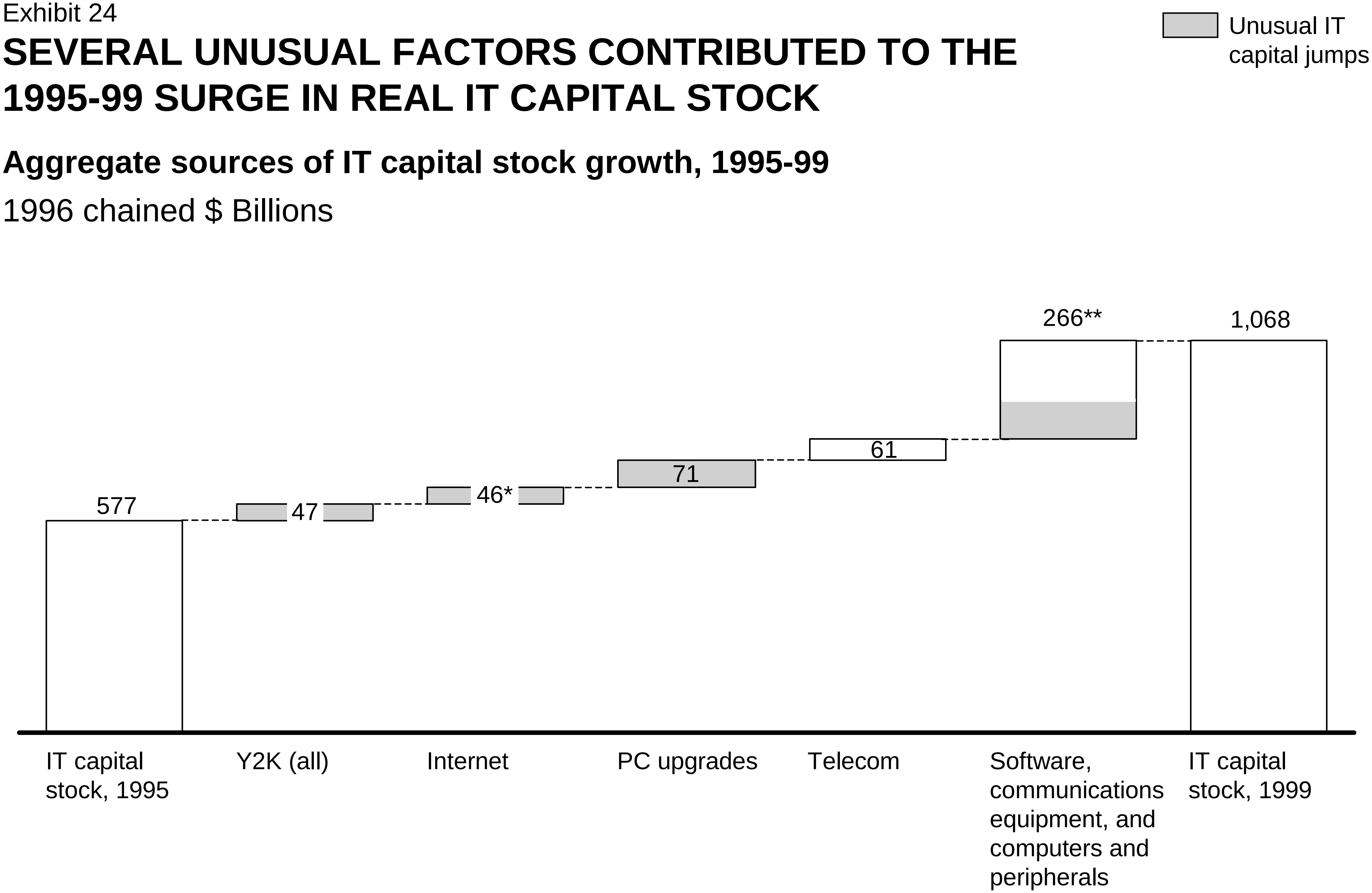
* Rapid innovation in optics also contributed to long haul and metro network investment surge

Exhibit 24

SEVERAL UNUSUAL FACTORS CONTRIBUTED TO THE 1995-99 SURGE IN REAL IT CAPITAL STOCK

Aggregate sources of IT capital stock growth, 1995-99

1996 chained $ Billions



* Excludes 2000, the largest year of Internet investment ($36 billion, nominal)

** Cumulative capital addition and depreciation

Source: BEA; 10K filings; IDC; Dataquest; Gartner; Rubins; Tower Group; MGI analysis

Exhibit 25

ABSENT THE UNUSUAL FACTORS, THE IT CAPITAL INTENSITY GROWTH RATE WOULD HAVE INCREASED FROM 6% (1987-95) TO 9.2% (1995-99), AT MOST, RATHER THAN TO THE ACTUAL 13.9%

1996 chained $ Billions

	All IT capital stock	IT capital stock excluding unusual capital stock increases
1995 capital stock	577	577
1995-99 capital stock increase	491	327
1999 capital stock	1068	904
1999 PEP (millions of people)	114	114
Capital stock/PEP ratio	**9,370**	**7,933**
Real IT intensity 1995	**5,570**	**5,570**
Real IT intensity CAGR, 1995-99	**13.9%**	**9.2%***

* CAGR based on midpoint of Capital Stock/PEP Ratio excluding unusual increases

Note: Unusual IT capital stock increases include Y2K, Internet, and accelerated PC upgrade-related investment between 1995 and 1999. Real IT intensity CAGR, 1987-95: 6.0%

Source: BEA; 10K filings; IDC; Dataquest; Gartner; Rubins; Tower Group; McKinsey analysis

Exhibit 26

SOME INDUSTRIES, SUCH AS HOTELS, PRESENT LIMITED OPPORTUNITIES FOR IT

Percent

	Rooms operation employment, 1998	IT investments that reduce labor	Timing of investment
Maids and housekeepers	42.3	• Labor scheduling**	• Not yet
Desk clerks	16.2	• Initial PMS installation	• Before 1995
Janitors and building cleaners	5.8		
Building maintenance	4.3		
Lodging managers and executives	4.0		
Baggage porters	2.8		
Bookkeeping and auditing clerks	1.8	• Back office automation • Property system integration	• Before 1995 • Before 1995
All others*	22.7		

* Largest other single occupations include other service supervisors, cashiers, guards, other service workers, and clerical supervisors

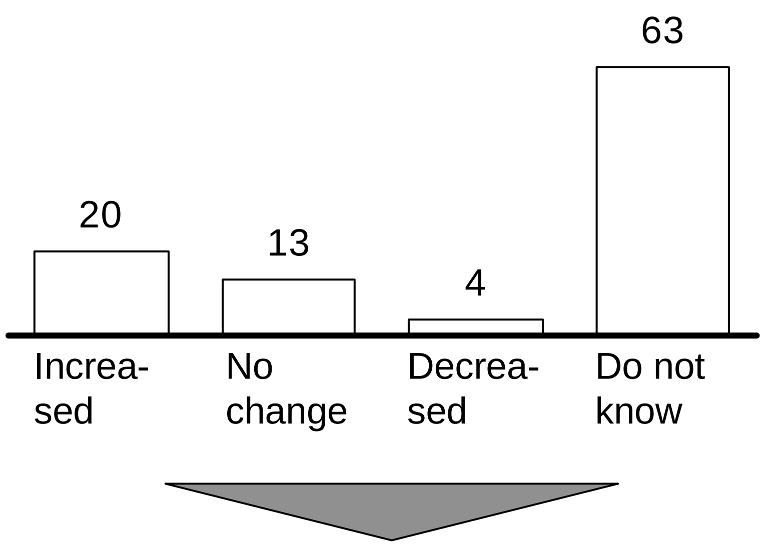
** Since labor scheduling reduces labor through process optimization, not automation, its productivity impact is more limited than other task-automating investments

Source: BLS; industry interviews; MGI analysis

Exhibit 27

ASSESSMENT OF CRM STRATEGIES

Impact of CRM – change in customer profitability
Percent of surveyed banks



80% of surveyed banks have not seen or are unsure whether CRM has increased customer profitability

CRM assessment from Gartner Group

- "55% of projects that apply technology to selling [have] fail[ed] to deliver measurable benefits. During the next 3 years, this will grow to 85%."

CRM assessment from CIOs and banking executives

- "Even today, the returns on data warehousing are dubious. OK, technologists, you have built this for us. How do we use it?"
- "A lot of the IT investment in retail banking has been in the area of customer acquisition, in a market that is not growing . . . the impact of this investment was stealing share, not growing the overall market . . . almost by definition, such investments will drive down productivity."
- "The way we deploy IT in our firm has created a shift in the way we do processes and practices. Anytime you see that shift or change, productivity will go down as people adjust to those new products."
- "The jury is still very much out on CRM."

Source: E&Y Banking survey; Gartner Group; Stephen Brooks; retail banking CIO/executive interviews

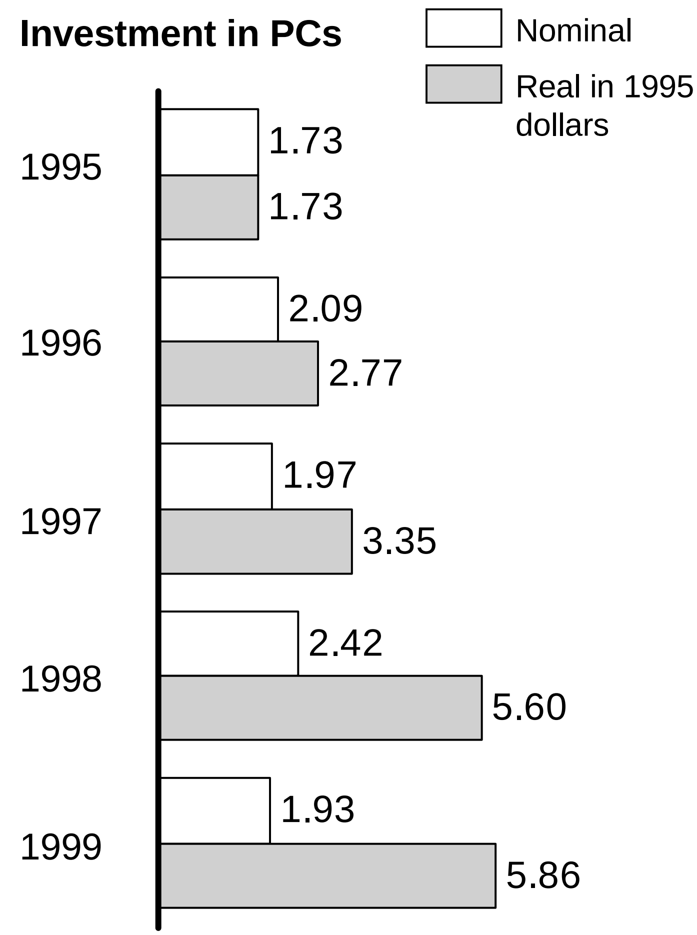
Exhibit 28

EVIDENCE OF EXCESS CAPACITY IN PCs

Anecdotal evidence

- "Although I am very pleased with the technology we deployed, we have not used all the capacity."
- "If there is any place where there is excess capacity, it is damn sure on the desktop. You have a tremendous amount of power that you are using only 1% of."
- "From the standpoint of utilization of the box and core software functionality, I would say there is not optimal utilization of the functionality people are buying."
- "[Say I'm a manager.] I requisition a piece of software based on the full functionality it offers. As I cost justify it, I build more functionality into the cost or revenue justification for it. After the purchase, it is an open question whether the IT group has the ability to make that functionality available at the desktop with quality, where it can be a productive asset."

Investment in PCs



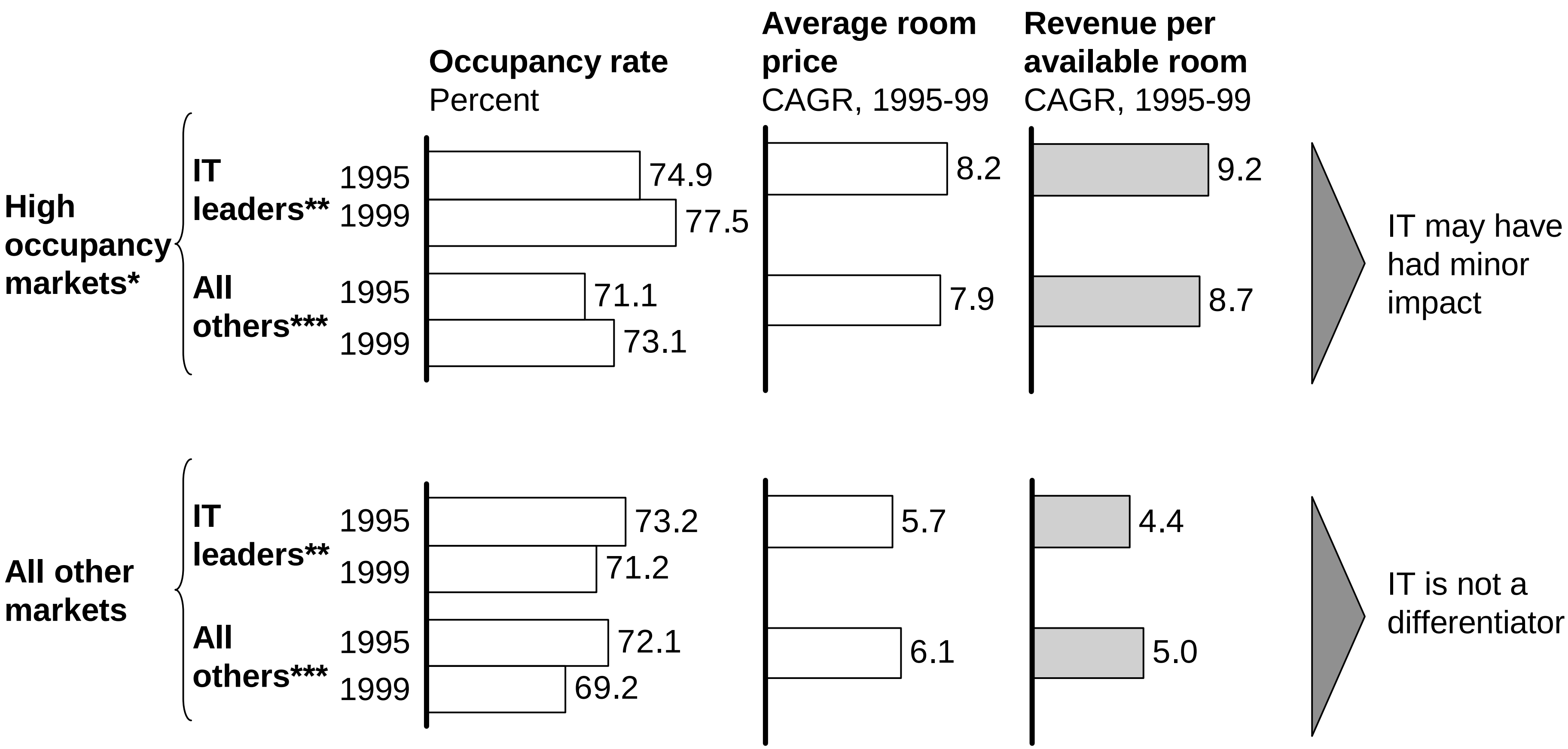
Source: Retail banking CIO/Executive interviews; BEA; MGI analysis

Exhibit 29

IT MAY HAVE HAD A MINOR IMPACT IN HIGH-OCCUPANCY MARKETS, BUT THE EFFECT WAS NOT LARGE

Upper upscale properties

Key industry performance measure



* New York, San Francisco, San Jose, Oakland, Boson, San Diego, Washington DC, Austin, Los Angeles, Baltimore, Chicago

** All Marriott, Hilton/Promus, and Omni upper upscale properties

*** Includes all Starwood, Hyatt, Wyndham, Fairmont, Inter-Continental, Park Plaza, Le Meridian upper upscale properties

Source: Smith Travel Research; MGI analysis

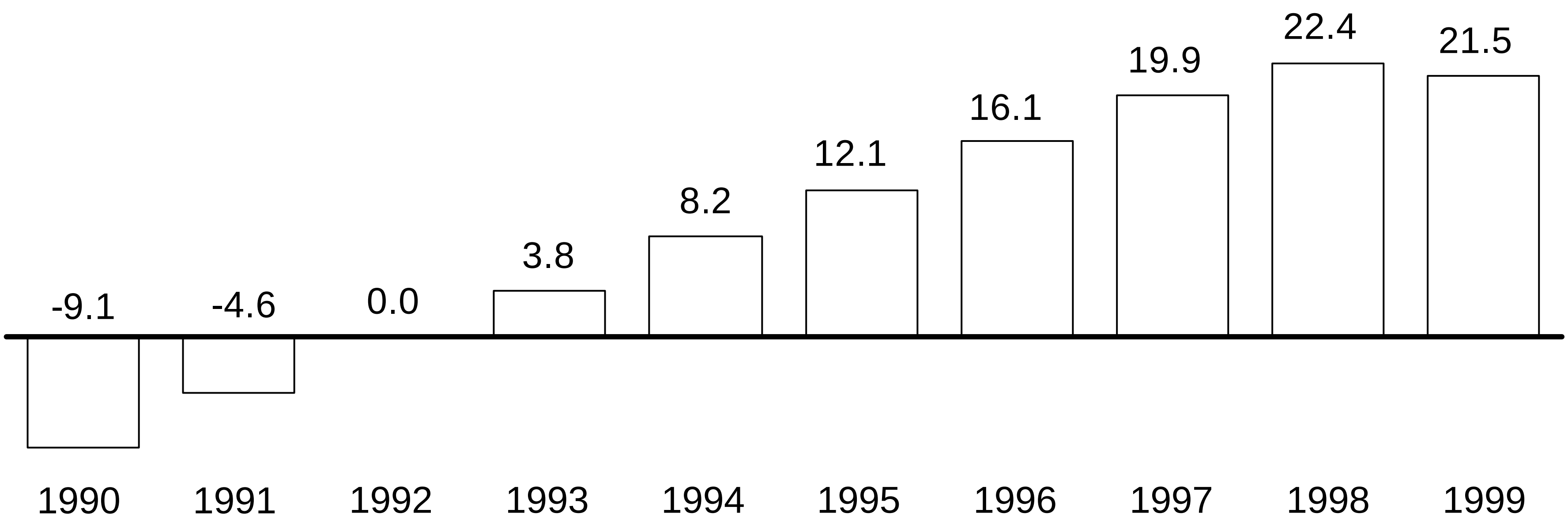
Exhibit 30

HIGH PROFITABILITY FOLLOWING MID-1990s RECOVERY MAY HAVE DIVERTED MANAGEMENT ATTENTION FROM FULLY EXPLOITING IT CAPABILITIES

Pre-tax industry profit margin*

Percent

"We've become fat and happy with our high profitability following the industry recovery in the 1990s . . . as a result, we've spent much less time focusing on operations and productivity"



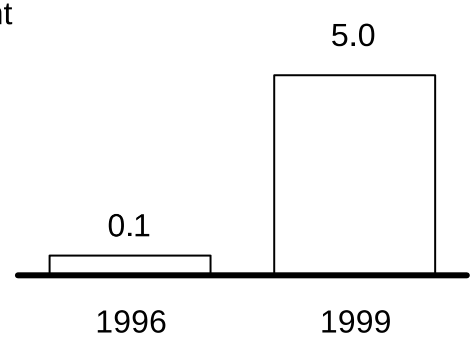
* Gross profit margin is 2.8% higher than industry average in high-occupancy markets

Source: Smith Travel Research; PriceWaterhouse Coopers; interviews with hotel executives and general managers; MGI analysis

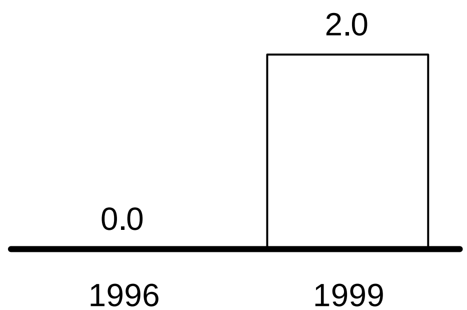
Exhibit 31

IMPACT OF ONLINE BANKING ON RETAIL BANKING LABOR PRODUCTIVITY

Active online customers*
Percent

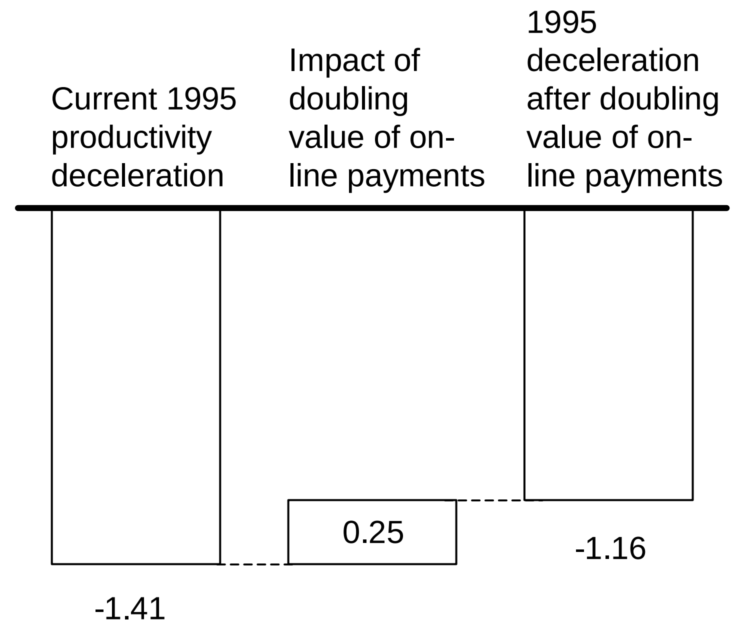


Online transactions/total banking transactions
Percent



Online banking penetration in 1999 was low

Impact of doubling the value of online banking payment transactions
CAGR, percent



Since the number of online payment transactions is very small, increasing their value will not reverse the 1995 productivity deceleration

* Active online customers defined as customers who access their online account more than once a month

Source: Online banking review; ABA

Prospective scenarios for US productivity growth

What are the prospects for US productivity performance over the medium term (2001-2005)? A review of recent US productivity patterns suggests that a near-term recession will not change the outlook for the productivity growth rate over the next four years because any short-term decline in productivity growth is likely to be accompanied by an uptick prior to 2005 as the economy recovers from recession. Therefore, over the medium term, it is the structural rate of productivity growth within the six "jumping" sectors, as well as the performance of the rest of the economy, that will play the key role. The discussion that follows addresses each of these in turn.

For the six jumping sectors, our analysis of what caused productivity acceleration in the 1995-99 period allowed us to assess with some confidence the likelihood that certain forces will or will not continue. Considerable uncertainty existed around other factors, whose impact we quantified. In the rest of the economy, we combined an examination of potential for future productivity growth jumps with a statistical analysis of historical productivity growth to develop a view on potential outcomes.

The end result is several plausible medium-term (2001-2005) scenarios, rather than a point estimate of or likely range for, future productivity growth. This approach allows readers to draw their own conclusions about the future based on their evaluation of the key uncertainties described below. In addition, it should provide a useful lens through which to evaluate in the future *why* productivity performance is unfolding as it is.

ANALYTIC APPROACH

The time period over which we assess future productivity potential is the medium term (2001-2005). The reason for this timeframe is that we believe analysis over a period that is significantly shorter or longer would not be terribly meaningful. In the very short term, macroeconomic movements can swamp structural trends in productivity growth. Beyond 2005 or so, our case studies are likely to become less reliable predictive tools. The 2001-2005 productivity growth rates embodied in our scenarios represent average annual rates over the entire period in question. As we have seen, productivity growth rates tend to vary considerably from year to year. (See Objectives and approach.)

Just prior to the completion of this report, the possibility that a near-term recession could occur increased substantially as the impact of tragically successful domestic terrorist attacks began rippling through the economy. We have sought to take that risk into account in developing a perspective on the future.

In order to do so, we reviewed annual labor productivity growth in the US private sector from 1977-1999. More specifically, we calculated the range of productivity growth rates over four-year periods beginning in 1977. (We used a four-year period to provide an appropriate comparison with the 2001-2005 projection period.) This analysis showed that if the US does enter a recession near the start of the 2001-2005 period, we would not expect the labor productivity growth rate for the ensuing four years to be below our structural expectations. (See Exhibit 1, which shows in that in four-year periods that include both a recession and the first year of the ensuing expansion, productivity growth is generally above average.)[1] Given this finding, our overall analysis of sustainable productivity growth does not include a cyclical factor for the probability of recession. It is important to note that our approach depends upon the assumption that any near-term recession will be similar to the 1981-82 and 1990-91 recessions, characterized by a sharp "V" in economic performance.

Our unit of analysis is the annual contribution of a sector or segment of the economy to total US productivity growth rate. These contribution figures are additive; their sum yields a potential annual rate of growth for the entire economy. Since these figures are based on contribution to overall productivity growth, rather than contribution to a productivity growth jump, they differ from, but are entirely consistent with, numbers describing contribution to productivity acceleration, including those in the "Synthesis" chapter.

All of our contribution analysis is based on the industry-specific, income-side data of the US Bureau of Economic Analysis (BEA). The Bureau of Labor Statistics (BLS), whose aggregate productivity figures are the benchmark watched by economists and policy makers, uses expenditure-side data. For several well-known reasons (see "Objectives and approach" and Exhibit 2 for details), aggregate productivity results differ slightly between BEA and BLS. Given the more pervasive use of the BLS figures, we scale our scenario results so that they are in BLS terms.

THE SIX JUMPING SECTORS

To understand future potential for our six jumping sectors, we attempted to assess the sustainability of the causes of both the sectors' 1995-99 productivity growth acceleration, and their longer-term base growth rates. (In other words, we sought to evaluate the entire 1995-99 productivity growth rate, not just the portion of it that represented acceleration from 1987-95 (Exhibit 3).) To do so, we first assessed the sustainability of the productivity acceleration in each sector. We then

[1] This finding also holds for the six jumping sectors. When we isolated their historical productivity performance, we found that their cumulative annual productivity growth rate for four-year periods beginning with recessions was above the 1977-1999 average.

incorporated the effects of any factors identified in the course of our analysis that could affect the sector's longer-term base growth rate.

Although we have not sought to "correct" for cyclical effects, given the results of the analysis above, it is worth noting that where particular cyclical factors helped cause the 1995-99 results, (i.e., the impact of the stock market bubble on the securities industry and the substitution to higher-value goods in retail and wholesale), we have either determined that the factors are simply unsustainable (i.e., for securities), or, in the case of substitution to higher-value goods, highlighted these as uncertainties and allowed readers to draw their own conclusions about the degree to which the factors are sustainable.

Summary of factors likely to be sustainable

Much of the productivity growth associated with the key causes of 1995-99 performance – business and technological innovation and changes in product market regulation – is sustainable. The sum of these factors is 0.63 percentage points, roughly 50 percent of the contribution made by the six jumping sectors to the 1995-99 productivity growth acceleration (Exhibit 4). In addition, our analysis suggests potential for accelerated contribution from select elements of the telecom and wholesale productivity growth jump (Exhibit 5).

- ¶ Future productivity growth in mobile and long-distance telecom services will benefit from further labor economies of scale because a significant portion of labor is fixed relative to usage, and demand is likely to continue expanding at high rates for the next four years. Demand growth should be fueled by continued price declines, further penetration of mobile phones, and increased usage of both mobile phones and long-distance (especially data) services.[2] As the highly productive telecom sector becomes an even larger share of the economy, we estimate that the sector's contribution to total productivity growth will not just equal but actually surpass 1995-99 levels. (See the outlook sections of the telecommunications sector case study for more detail.)
- ¶ The productivity growth of the securities and brokerage sector benefited from a convergence of several factors, many of which are likely to endure. These factors consist of the penetration of on-line trading, further automation of trade processing, and further penetration of mutual funds. Additional price declines (made possible by further automation and encouraged by SEC efforts) should allow a significant portion of the trading volume growth that occurred in 1995-99 to be sustained. (See the

[2] Mobile penetration in the US is still below that in Europe, suggesting opportunities for further penetration. The rate of penetration, however, is likely to slow. (See Telecommunications Services case study for details.)

outlook sections of the securities and brokerage sector case study for more detail.)

¶ The continued diffusion of warehouse automation and other best practices, combined with the continued pace of progress in pharmaceutical research and development, makes the contribution of the wholesale drugs sector sustainable. In addition, the penetration of warehouse automation systems is still relatively low for the wholesale sector as a whole. The accelerated adoption of warehouse automation in the rest of wholesale is likely to cause productivity growth associated with these systems to contribute even more, 2001-2005, than it did, 1995-99. (See the outlook section of the wholesale sector case study for more detail).

¶ In the semiconductor industry, the performance improvement of the basket of microprocessors sold should continue at its 1995-99 rate. The industry can achieve such performance if Moore's law continues at its historic rate and product lifecycles remain at their current length. Intel's public statements about future chip releases through 2002 and potential transistors per chip in 2007 suggest that the industry may be able to do even better. Consequently, a base assumption of improvement at 1995-99 rates appears conservative. Continued improvement at 1995-99 rates will also positively impact the productivity growth rate of the computer manufacturing industry. (See the outlook sections of the semiconductors and computer manufacturing sector case studies for more detail).

¶ The diffusion of best practices in retail general merchandising (GMS) (i.e., organization of functions and tasks and IT best practices) is likely to continue, given the sizable productivity gap between the best practice player, Wal-Mart, and the rest of GMS. (See the outlook section of the retail GMS sector case study for more detail.)

¶ In the rest of retail (i.e., outside GMS), a portion of economic activity is concentrated in subsectors in which "category killers" that are somewhat analogous to Wal-Mart exist. An analysis of large, high-growth firms (see below for details) reveals that in 1999, three large retailers (Home Depot, The Gap, and Staples) had sales in excess of $5 billion and 1995-99 revenue growth rates in excess of 30 percent (similar to Wal-Mart's during 1990-95).[3] We believe the portion of retail in which category killers are active is more likely to benefit from the diffusion of productivity enhancing best practices, and that a portion of the rest of

[3] In 1995, Wal-Mart, Best Buy, Circuit City, and Office Depot all had grown in excess of 30 percent per year since 1995.

retail's productivity contribution associated with category killers (and exclusive of the substitution to higher-value goods) is sustainable.[4]

While the existence of several large, fast-growing firms in retail could mean that additional up-side beyond 1995-99 performance exists, the fact that the current productivity gap between, e.g., Home Depot and the rest of its market (roughly 20 percent) is significantly smaller than Wal-Mart's 1995 advantage (greater than 40 percent) suggests there may be less room for further acceleration than there was in 1995. Our scenarios do not include retail productivity growth acceleration beyond 1995-99 levels.

Summary of factors likely to be unsustainable

Our analysis suggests that the 1990s boom benefited productivity growth in the securities, semiconductor, and computer manufacturing industries to an unsustainable degree. The sum of these contribution factors is 0.24, roughly 15-20 percent of the contribution made by the six jumping sectors to the 1995-99 productivity growth acceleration (Exhibit 6).

¶ The experience of the last 12 months suggests that a number of factors that contributed to the acceleration in the productivity growth rate of the securities industry were linked to exceptionally buoyant financial markets. These factors were the portion of trading volume growth attributable to the irrational exuberance of on-line traders, the surge in investment banking deals and valuations, and the fast appreciation of assets under management of mutual funds. (See the outlook sections of the securities and commodity broker sector case study for more detail).

¶ A number of factors point to a slowdown in the demand for computers and therefore microprocessors. Our analysis suggests both that businesses and, to a lesser degree, consumer markets have passed the inflection of their penetration curves beyond which demand is likely to slow. This fact, combined with the subsiding of demand associated with several features unusual to the 1995 period (e.g., the emergence of the Internet, systems upgrades associated with Y2K, and rapid upgrade cycles during the period in which a standard and efficient PC platform was becoming firmly established) should lead to lower unit demand growth. Recent PC sales growth and CIO surveys provide confirmation of these trends. This slower unit demand growth will reduce the degree

---

[4] We have applied a discount factor to the "category killer" contribution figures because targeted analysis of the rest of retail did not uncover sectors with productivity differentials between the leader and the rest of the market as large as those between Wal-Mart and the rest of retail GMS in 1995.

to which the computer manufacturing and semiconductor sectors can reap the benefits of economies of scale. (See the outlook sections of the semiconductors and computer manufacturing sector case studies for more detail).

Sources of uncertainty

Two key sources of uncertainty exist within the retail and wholesale sectors. The sum of these contribution factors is 0.50, roughly 30-35 percent of the contribution made by the six jumping sectors to the 1995-99 productivity growth acceleration (Exhibit 7).

¶ The first uncertainty is the degree to which the substitution by consumers to higher-value goods will continue at its accelerated 1995-99 pace, or revert to 1987-95 levels. This shift was mainly the result of growing confidence, income, and wealth, rather than a concerted effort by retailers to entice consumers to upgrade. Given the difficulty of fully explaining human behavior, the scenarios below assume two extreme cases: An upper bound case in which all of this substitution is sustainable, and a lower bound case in which none of it is.

¶ The second source of uncertainty concerns the remaining portions of the sectors that we did not study in detail (i.e., wholesale productivity growth not associated with the drugs sector, warehouse automation, or the substitution to higher-value goods, whose uncertainty is treated separately; and retail productivity growth not associated with the GMS sector or the substitution to higher-value goods, whose uncertainty is treated separately). The scenarios below assume two extreme cases: An upper bound case in which all of this contribution is sustainable, and a lower bound case in which the only sustainable portion is a subset of that attributable to the subsectors of retail in which a "Wal-Mart-like" category killer exist.

* * *

Within the six jumping sectors, at least 50 percent of the 1995-99 productivity acceleration appears to be sustainable, 15-20 percent is unsustainable, and 30-35 percent is uncertain. However, this analysis is insufficient to develop a perspective on the future. In spite of the disproportionate contribution of the six sectors to the 1995-99 productivity growth jump, the productivity performance of the rest of the economy will have a significant impact on 2001-2005 US productivity growth.

THE REST OF THE ECONOMY

We have relied on two approaches for considering the potential future productivity performance of the rest of the economy that we have not studied. First, we applied the microeconomic perspective on economic growth that arose from our case studies, to determine whether a large number of sectors appeared amenable to productivity growth jumps occasioned by triggering events and competitive responses. The results of this analysis suggested that it would not be surprising for several new sectors to experience productivity growth jumps in the next few years.

Our aggregate analysis (see "Objectives and approach" chapter) revealed that productivity growth is normally accompanied by a few sectors jumping a significant amount. While these jumps are embedded in the long-term productivity trend, they certainly do not comprise the entirety of the trend. What was unusual about the 1995-99 period was that the employment share of some of the jumping sectors was extremely large (i.e., wholesale and retail), and the size of the measured productivity growth jumps in some other sectors (e.g., semiconductors and computer assembly) was also very large. When we applied our microeconomic perspective on growth to the rest of the economy, it yielded potential jumping sectors whose total number (seven) and employment share did not appear unusual. Furthermore, only one of the sectors appeared amenable to an unusually large jump. For these reasons, we employed a second approach involving the historic volatility of productivity growth in the rest of the economy to develop future scenarios.

Sector potential for future productivity growth jumps

Our case studies suggest that triggering events, particularly emerging business or technological innovation and/or regulatory change, facilitate productivity growth jumps. (See appendix for a more detailed microeconomic perspective on economic growth.) We have drawn upon these findings to develop a perspective on future productivity potential in specific sectors of the economy.

The importance of innovating firms as triggers, combined with the requirement that they be sufficiently large to occasion a competitive response, suggests that identifying large, high-growth firms is a potentially fruitful means of highlighting sectors with potential for medium-term productivity growth jumps. If large, high-growth firms have a significant productivity advantage over other firms in their sector, competitive responses can yield sector-wide productivity improvement.

Our case studies suggest a rough screen for identifying firms:

- ¶ **Growth:** Innovative business models are likely to achieve rapid growth. Wal-Mart, for example, grew more than 30 percent per year from 1990-1995. We screened for companies with sales growth in excess of 30 percent per year.[5]

- ¶ **Size:** We view size as an important criterion for two reasons. First, large firms may be able to independently move the national productivity needle. Second, large size is necessary to attract the attention of other firms and occasion competitive responses. Wal-Mart's market share in 1995 was roughly 30 percent. Our screen requires that a firm have sales equal to roughly 30 percent of a market sufficiently large to have a measurable impact on national productivity growth rates.[6]

As a check, we applied this screen to the 1990-95 period. Two conclusions result from this analysis:

- ¶ Most of the 1995-99 jumping sectors emerge as high-potential contributors from this analysis (Exhibit 8). The sectors that emerged were computer manufacturing, semiconductors, wholesale, and retail.[7] The sectors that did not emerge were telecom and securities brokerage, and there were clear reasons pertaining to the timing and ownership structure of the business innovators that caused this result.[8]

- ¶ Several other sectors also appeared, suggesting that this form of analysis is likely to be over- rather than under-inclusive of sectors with high potential.

---

[5] In doing so, we sought to eliminate those firms whose growth was largely a result of acquisitions made simply to leverage fixed costs. Such growth is less likely to trigger widespread productivity enhancing responses from competitors. On the other hand, acquisitions made with the purpose of diffusing an innovative business approach (as evidenced by the 1995-99 consolidation and automation of the wholesale pharmaceuticals industry) are more likely to yield sector-wide productivity benefits. Therefore, we have sought to not exclude such acquisitions. Interestingly, our rough qualitative screen revealed that most acquisitions fall into the former rather than the latter category.

[6] We estimate the size of such a market to be roughly $16 billion in 1999. This corresponds with 0.1 percent of US gross output, and is the rough size of a market whose jump could incrementally move the national productivity needle (i.e., contribute an incremental 0.01 percentage points to productivity growth). The resulting sales level is $3.8 billion in 1995 and $5 billion in 1999. This criterion is potentially over-inclusive because many firms of this size are in much larger markets, and therefore lack Wal-Mart's 30 percent market share. Since we are simply scanning for opportunity, our preference is to be over- rather than under-inclusive.

[7] Wal-Mart, Best Buy, Circuit City, and Office Depot appeared in retail; Intel appeared in semiconductors; Dell and Compaq appeared in computer manufacturing; Cardinal Health appeared in wholesale drugs.

[8] The mobile telecom providers did not appear because their industry was still nascent in 1995 and they were parts of telecommunications giants (e.g., AT&T Wireless, Sprint PCS). E-Trade, Charles Schwab, and other on-line innovators did not appear in securities brokerage, and this is unsurprising for two reasons. First, the Internet segment of the securities industry was virtually nonexistent during 1990-95. Second, on-line trading was only a relatively small contributor to the overall securities growth jump, much of which was attributable to demand and regulatory factors not caused by a specific business innovation or innovator.

Repeating the analysis in 2000, based on 1995-2000 performance, yielded the following results (Exhibit 9).

- Many of the six 1995-99 jumping sectors still emerged. This finding offered confirmation of our case-based perspective that a sizable portion of the 1995-99 productivity growth acceleration in the six jumping sectors is sustainable.

- Five other sectors (business services, specifically software, media/motion pictures, insurance carriers, and depository and nondepository institutions) emerged.[9] Several of the firms that caused these sectors to pass the screen (e.g., Microsoft, AOL Time Warner, and Wells Fargo) are household names, as were the large firms critical to the 1995-99 productivity growth jump.

In addition to business innovation, regulatory change can be an important triggering event. A high-level review suggests at least two additional sectors may be impacted by recent competition-inducing regulatory changes (Exhibit 10). They are chemicals (specifically pharmaceuticals) and electric, gas, and sanitary services.[10] Future, unforeseen regulatory changes represent up- and down-side risks for many industries.

Thus, a quick scan of the rest of the economy suggests that seven additional sectors could experience productivity acceleration due to triggering events of the sorts identified as meaningful in our case studies. Interestingly, these seven sectors are not unusual in their size. Nor do any, with the possible exception of media, appear amenable to extremely large productivity jumps.[11] Moreover, even a large media jump would not approach the magnitude (i.e., 20-30 percent per annum) of the computer manufacturing and semiconductor industries' jumps.

Exhibit 11 summarizes the potential cumulative impact of 3 percent annual productivity growth jumps in each of the seven sectors identified. We regard 3 percent as a meaningful figure because the 1995-99 retail GMS jump of nearly 5 percent resulted from competitive responses to a player (Wal-Mart) with a greater than 40 percent productivity advantage. Our analysis in the rest of retail suggests that a gap of this magnitude is extremely unusual; even other category killers

---

[9] See retail banking case study for a summary of future opportunities for depository institutions. Opportunities include obtaining larger medium-term productivity benefits from some IT investments than banks have to date, continuing to migrate customers to more efficient channels like voice response unit (VRU) call centers and ATMs, and shifting customers from paper checks to on-line transactions and electronic payments. Retail banking's high (though recently decelerating) productivity growth rate sets a high performance bar for the industry to experience a significant productivity growth jump.

[10] Depository institutions and insurance carriers, which passed through the screen for growth and size, also have experienced recent regulatory changes that could spark competition-induced innovation.

[11] For example, significant productivity benefits might result if new media players such as AOL Time Warner were able to fundamentally shift the nature of content delivery in a manner that dramatically improved labor productivity growth in the distribution of motion pictures or published materials.

typically have a gap of only half that size. The 3 percent figure seems a reasonable estimate for the impact of productivity-enhancing responses to an industry leader possessing impressive advantages over its competitors, but lacking Wal-Mart-like dominance.

The impact of 3 percent annual jumps on the aggregate productivity contribution made by the seven, high-potential sectors would be comparatively small and does not suggest that these jumps, taken together, are terribly unusual. Given this result, we have relied on statistical analysis of the rest of the economy's productivity growth rate and volatility to develop our scenarios.

Statistical analysis of the rest of the economy

A review of the historical performance of the rest of the economy reveals that both its contribution to productivity growth (0.2 percent) and its average annual productivity growth rate have been quite small over the past two decades. There is, however, considerable volatility in the average annual rate of productivity growth across individual years. Two kinds of variance exist: variance caused by business cycles, and natural volatility in performance as a result of different industry dynamics and firm-level changes in each industry. Our intent is to exclude the business cycle variance from our statistical analysis of the rest of the economy, given the high likelihood of sharp cyclical productivity swings compensating for one another over a four-year period, while taking into account the existence of unpredictable, natural volatility. Taking these factors into account, we estimate that the likely contribution of the rest of the economy to productivity growth over the medium term is between +0.4 percent and -0.1 percent.

¶ Over the period 1977-99, the maximum 4-year CAGR for the rest of the economy is +0.8 percent and the minimum is -0.9 percent, implying a contribution to productivity growth between +0.6 percent and -0.6 percent (Exhibit 12.)

¶ The results on either extreme are not terribly plausible. They can be obtained only by choosing three high-growth years ending at the peak of a cycle, or three low-growth years terminating at the bottom of a cycle. As we have seen, the historical experience shows annual productivity growth rates in the rest of the economy peaking during rebounds from the trough of recessions. Our intent is to focus on periods that capture both productivity up- and down-turns.[12]

[12] Although it is impossible to know exactly when either the productivity up- or downturn will occur, recent historic experience suggests strongly that they will occur close together. Therefore, even if the 2001-2005 period does not

¶ A more reasonable range for annual productivity growth outside of the six sectors is between +0.5 percent and -0.1 percent (which translates to a contribution range of +0.4 percent to -0.1 percent). This range excludes four-year periods in which a recession took place and the first year of an expansion did not occur, and periods in which the first year of an expansion took place absent a recession.

Sources of uncertainty

Two key uncertainties exist.

¶ The first uncertainty is the contribution of the rest of the economy (between +0.4 percent and -0.1 percent)

¶ A second uncertainty is whether breakthrough applications of technology facilitate productivity-enhancing business innovations that are not encompassed by our analysis of historical productivity volatility. Since AOL Time Warner emerged from the screening process described above, we have used it and a "new media" productivity surge as a proxy for this possibility, and have built in some additional up-side contribution potential (0.06 percent) to reflect it.[13] This source of uncertainty should not suggest that we believe such an occurrence is likely. Rather, we are simply trying to capture the possibility that unforeseen business innovations associated with the application of new technology could have a positive impact on productivity growth that is not captured by our historic statistical analysis.

In the AOL Time Warner example, the 0.06 percent contribution represents a 6 percent annual productivity growth jump in AOL Time Warner's media subsectors (i.e., publishing and motion pictures). We assume that the contribution of a more typical 3 percent jump in these subsectors would be encompassed by our historic statistical analysis of the rest of the economy. The incremental 3 percent jump and the 0.06 percent contribution associated with it is a proxy for an "unusual jump" scenario.

The historic volatility of the rest of the economy (-0.1 percent to +0.4 percent) is much larger than the potential incremental impact of even a significant unusual jump (+0.05 percent). In fact, the volatility of the rest of the economy is the

---

contain both productivity downturn and bounceback, a counter-balancing up- or down-tick would likely occur soon after 2005.

[13] The .06 percent contribution is based on BEA, income-side data, and translates to an incremental .05 percent in BLS terms. See Exhibit 14.

largest single source of uncertainty and is treated independently from all others in the scenario analysis below.

PLAUSIBLE SCENARIOS, 2001-2005

The uncertainties enumerated above allow us to develop scenarios for the future. To simplify the development of scenarios, we have grouped our uncertainties into two categories. The first category corresponds primarily with uncertainties around the key six sectors. The second category corresponds with uncertainty around the volatility of the rest of the economy's productivity performance. For each category, we have developed "high" and "low" scenarios corresponding with estimated maximum and minimum levels of productivity growth. The two categories of uncertainty then interact to generate four base case scenarios, which are set forth in Exhibit 13. These scenarios aggregate and translate the BEA contribution figures set throughout this chapter into BLS terms to generate figures comparable with the benchmark productivity figures to which policy makers most frequently refer.[14]

The specific variables that play into the high and low scenarios on each dimension are as follows:

¶ **Key six sectors plus "unusual jump."** The upper bound scenario assumes that productivity growth associated with the substitution to higher value goods and the portions of retail and wholesale we did not scrutinize in depth is entirely sustainable. It also assumes that an unusual jump occurs that is not encompassed by our historical volatility range for the rest of the economy. The lower bound scenario assumes the opposite (i.e., substitution to higher-value goods and non-scrutinized portions of retail and wholesale entirely unsustainable; no unusual jump occurs elsewhere).

¶ **Volatility in the rest of the economy.** The upper bound scenario assumes that the rest of the economy contributes at the high end of its plausible historical volatility range (+0.4 percent). The lower bound scenario assumes that the rest of the economy contributes at the low end of its plausible historical volatility range (-0.1 percent).

Our intent in developing these scenarios has been to consider only options that could plausibly occur. We believe that any of the four scenarios set forth above is a legitimate possibility. The scenario results (1.6 percent, 2.0 percent, 2.1 percent,

---

[14] This translation from the BEA's sector-based data to a BLS-equivalent measure is carried by applying the ratio of sustainable acceleration as measured in BEA terms to the acceleration as measured by the BLS.

and 2.5 percent productivity growth rates) emphasize the degree of uncertainty inherent to forecasting efforts.

Disaggregating future scenarios

Some readers may wish to either disaggregate elements of the upper bound and lower bound scenarios in the "key six sectors plus 'unusual jump'" category, or consider the possibility that the rest of the economy performs in an average, rather than above- or below- average, manner. To simplify this process, we have set forth a menu of options corresponding with each of the key uncertainties. Exhibit 14 summarizes these options.

* * *

The results of this analysis suggest that whether or not a near-term recession occurs, productivity performance in the next four years is likely to be slightly better than it was in 1987-95, although no better than 1995-99. This conclusion is consistent with our broader finding that a substantial portion of the 1995-99 US productivity acceleration was structural in nature. Many of the underlying product, service, and process innovations underlying it should continue to generate productivity growth above the long-term (1972-95) trend.

APPENDIX: MICROECONOMIC PERSPECTIVES ON ECONOMIC GROWTH

MGI's case studies suggest a causal model for productivity growth jumps, whose application yields useful insights about future economic potential. Taken together, our case studies highlighted causal factors that foster economic growth. These factors are similar to some of those commonly recognized in the academic literature on this topic. The contribution of our work was to highlight which factors were critical to productivity growth as opposed to facilitators.

We have found that productivity growth in an economy occurs through two steps:

¶ **Triggering events**. These triggers can range from managerial and technological innovation to regulatory change. In this first stage, a limited number of firms typically stand out by forging ahead of the industry.

- Business / technological innovation. The development of the Wal-Mart format is exemplary of business innovation. Examples of technological innovation include digital cellular equipment in mobile telecom, more advanced storage devices and other components in the computer industry, and e-brokers. Some on-line brokerage players (e.g., E-trade) embody the Silicon Valley model of innovation, in which many small companies make innovative contributions.

- Regulatory changes. Examples of such changes were found in the securities, telecom, and retail banking sectors.

  – Productivity jumped in the securities industry in part due the SEC's efforts to increase competitive intensity and reduce trading charges.

  – Productivity jumped in the telecom industry, 1984-1987, following the breakup of AT&T. (See telecom case study for details.)

  – Productivity jumped in the retail banking industry, 1982-1987, following the Depository Institutions Deregulation & Monetary Control Act. (See retail banking case study for details.)

¶ **Diffusion of these effects to other companies within an industry**. The extent to which this diffusion affects the economy depends on the size of the sectors in which it happens. This diffusion generally depends upon high levels of competitive intensity. Specifically, it can occur through three major methods. These are:

- Learning and imitation as was the case for other firms in retail copying the Wal-Mart format;

- Consolidation where more productive firms spread best practices through acquisition, exemplified by pharmaceutical wholesalers; and
- Market share gains by best practice players, as seen in the telecom industry by the rapid growth of MCI and Sprint.

CONFIDENTIAL

Prospective Scenarios for U.S. Productivity Growth

MGI/HIGH TECH PRACTICE NEW ECONOMY STUDY

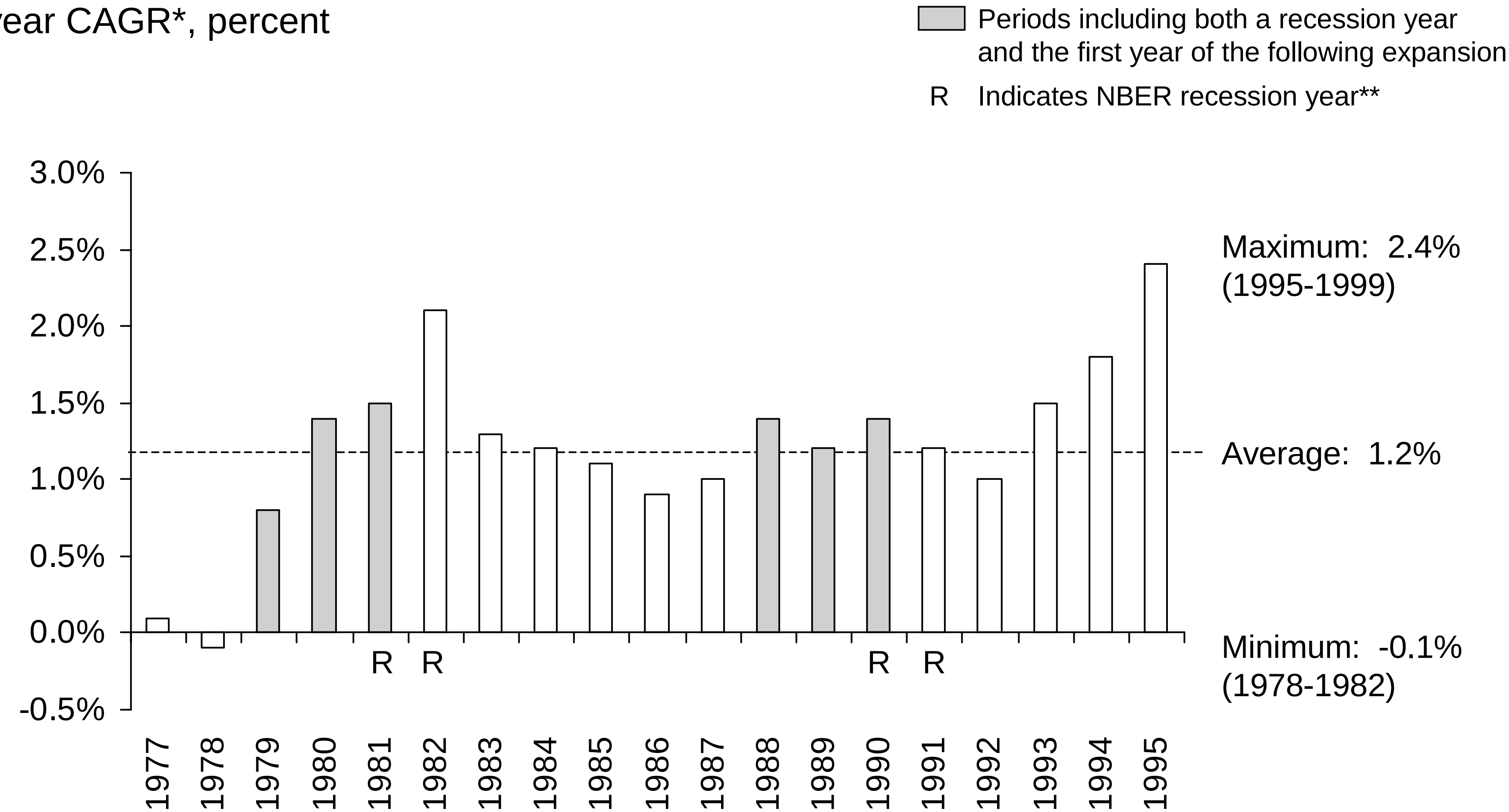
Exhibits

October 10, 2001

Exhibit 1

LABOR PRODUCTIVITY GROWTH IN U.S. PRIVATE SECTOR

4-year CAGR*, percent



* Each year's growth rate represents the 4-year CAGR beginning in that period (for example, 1978 represents growth over the period 1978-82)

** Years in which the economy moved from a National Bureau of Economic Research (NBER) "peak" in economic activity to a "trough"

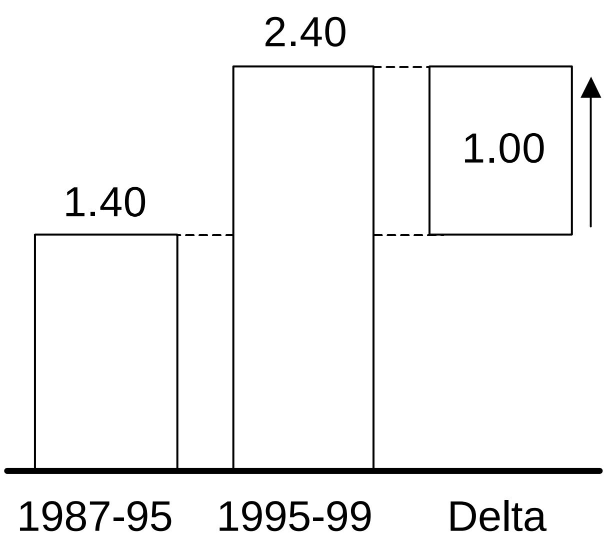
Source: BEA, MGI analysis

Exhibit 2

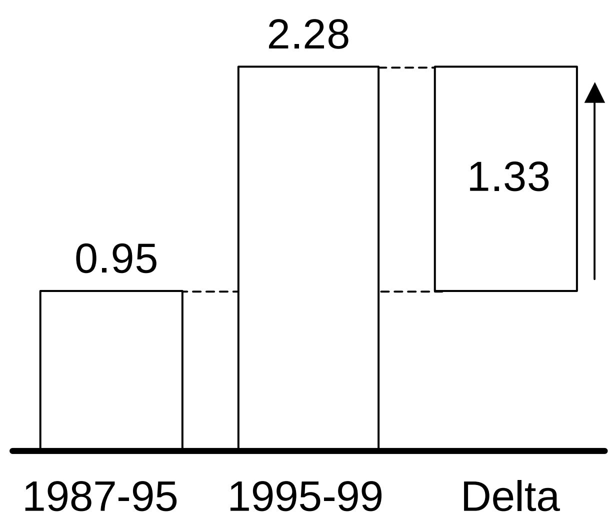
BLS OFFICIAL PRODUCTIVITY STATISTICS DIFFER FROM MEASURES BASED ON BEA INCOME-SIDE DATA

CAGR

BLS*



BEA sector data**



Output and input measures		Key differences
Expenditure side output	Income side, sector data	Statistical discrepancy
Hours	Workers ("PEP")	Hours per worker

* U.S. non-farm private business

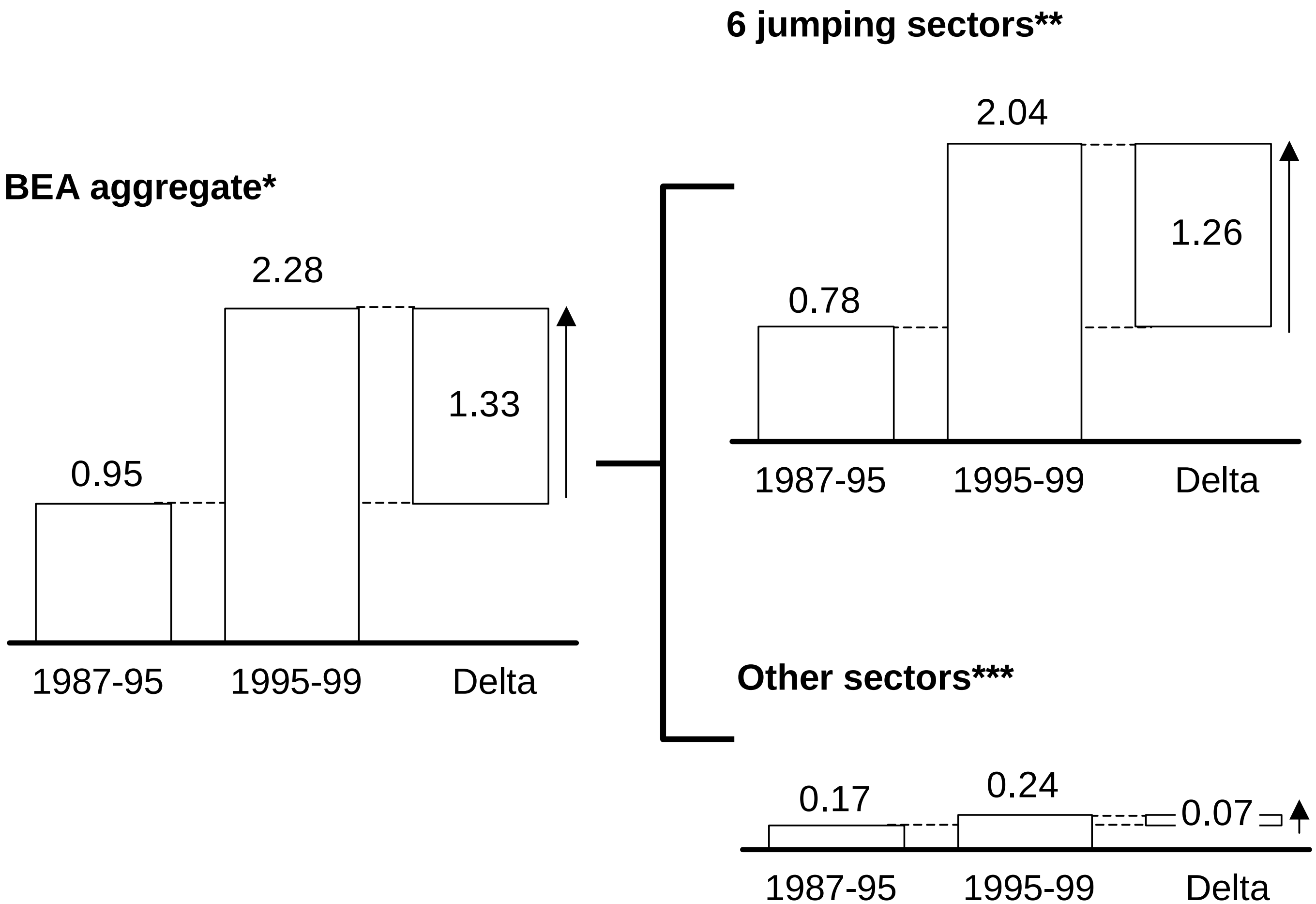
** Contributions of non-farm private business to GDP per PEP

Source: BEA; BLS; MGI analysis

Exhibit 3

DISAGGREGATION OF BEA SECTOR DATA

CAGR



* Contributions of non-farm, private business to GDP per PEP

** Based on MGI productivity measures

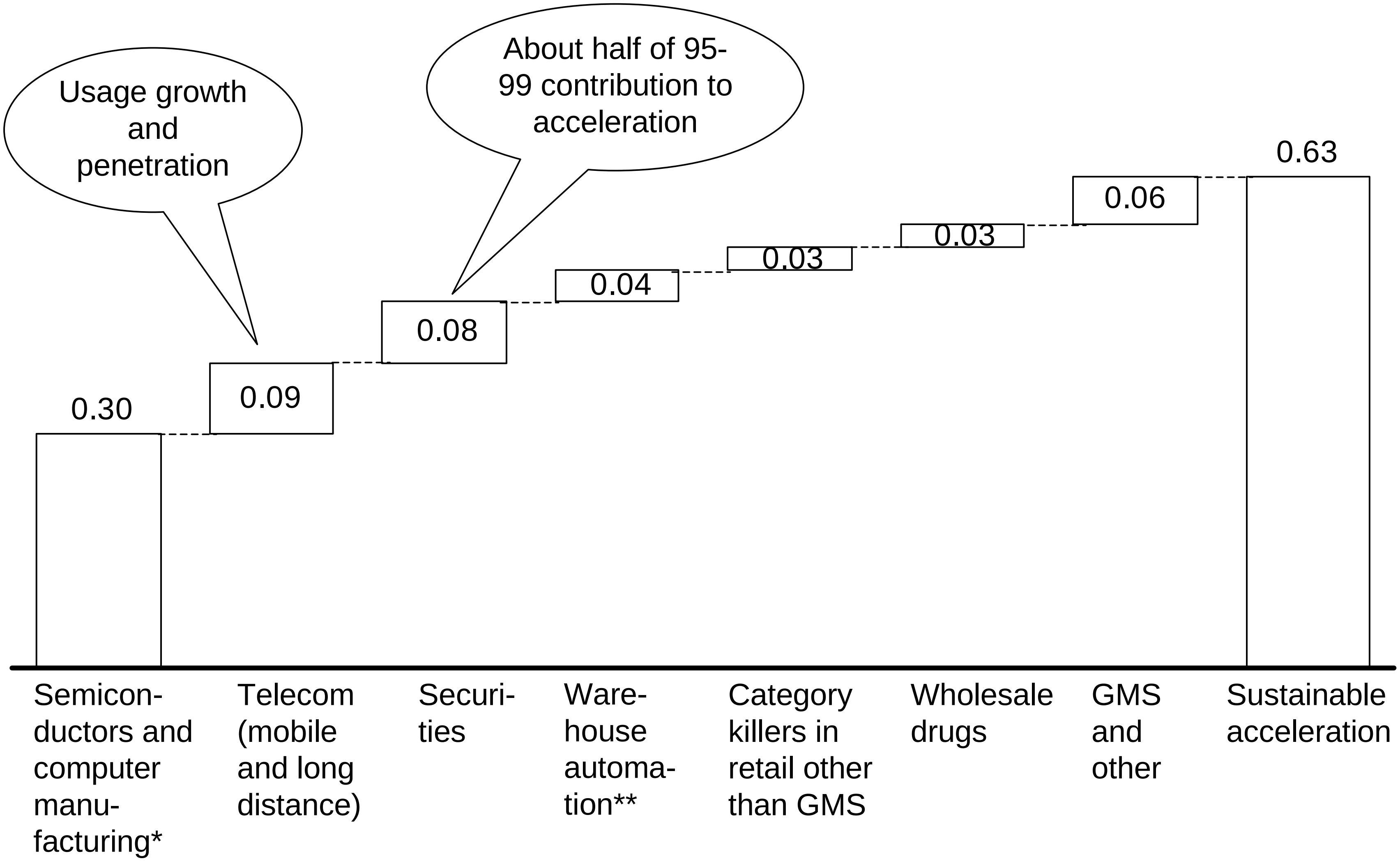
*** Difference between aggregate and 6 jumping sector contributions

Source: BEA; BLS; MGI analysis

Exhibit 4

SOURCES OF SUSTAINABLE PRODUCTIVITY ACCELERATION

CAGR, contribution



* Due to sustainable faster performance improvement

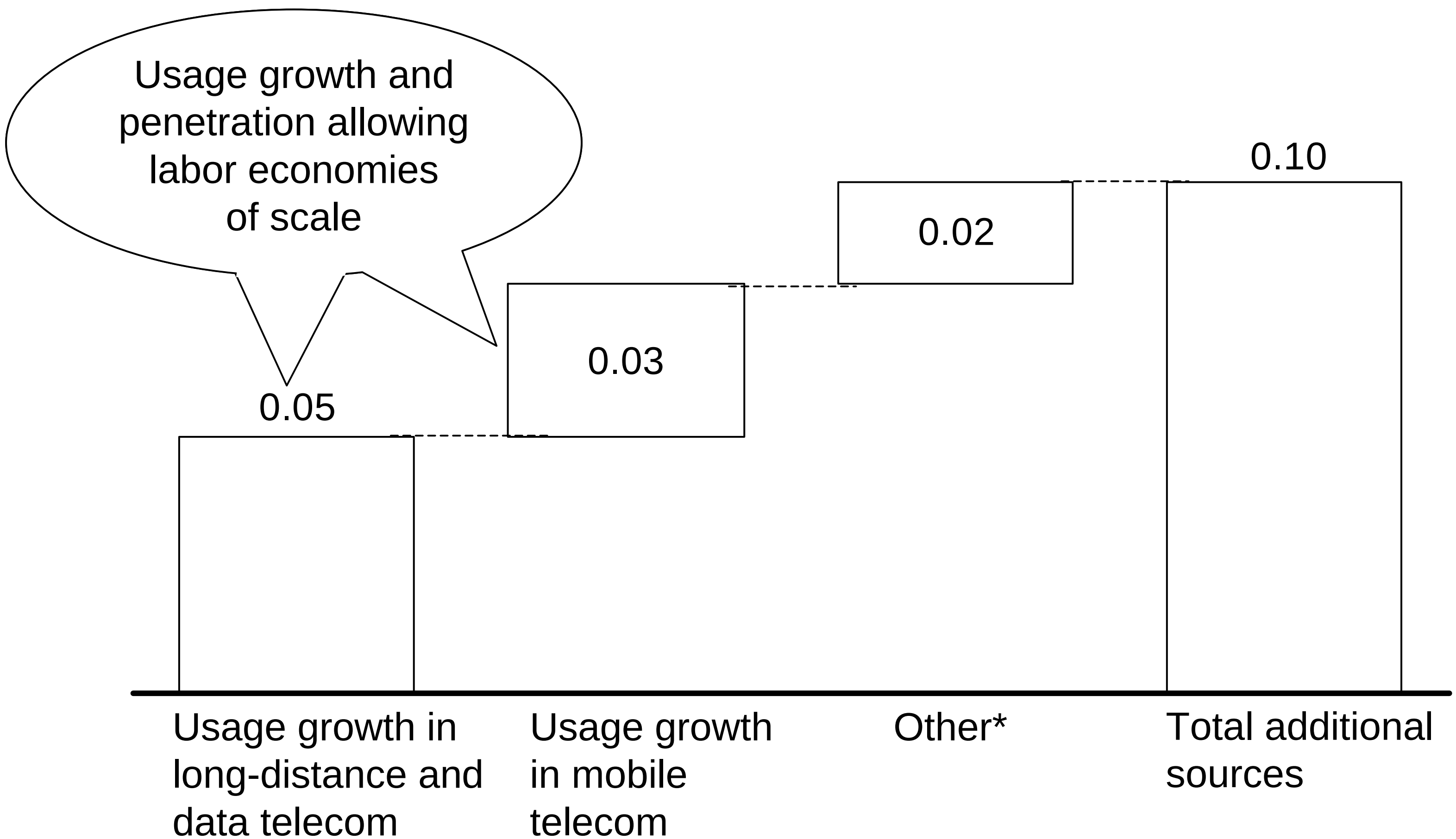
** Outside wholesale drugs

Source: MGI analysis

Exhibit 5

ADDITIONAL SOURCES OF SUSTAINABLE PRODUCTIVITY ACCELERATION

CAGR, contribution



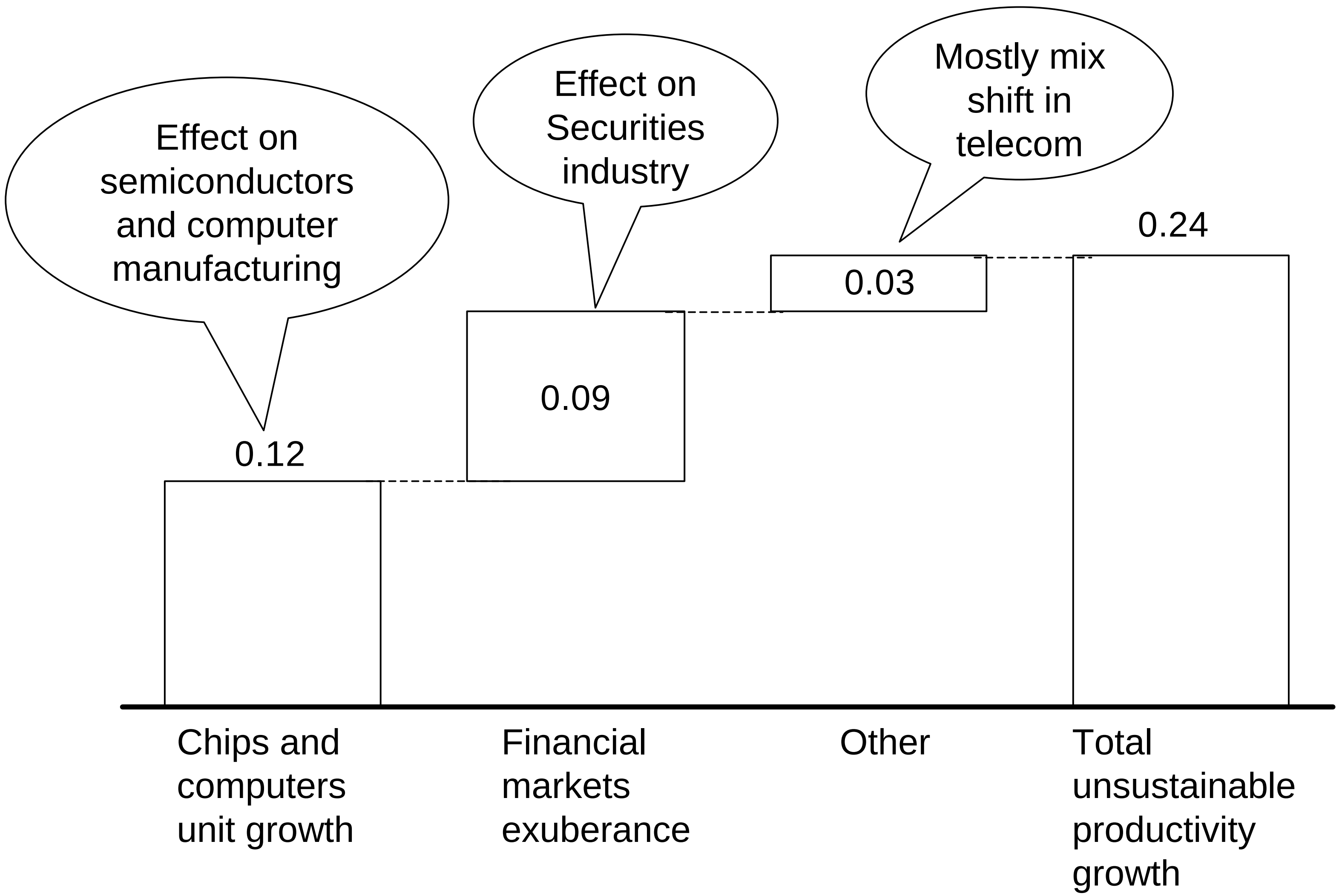
* Usage growth in local telecom allowing labor economies of scale and mix effect, and faster warehouse automation in wholesale (outside wholesale drugs)

Source: MGI analysis

Exhibit 6

SOURCES OF UNSUSTAINABLE PRODUCTIVITY ACCELERATION

CAGR, contribution

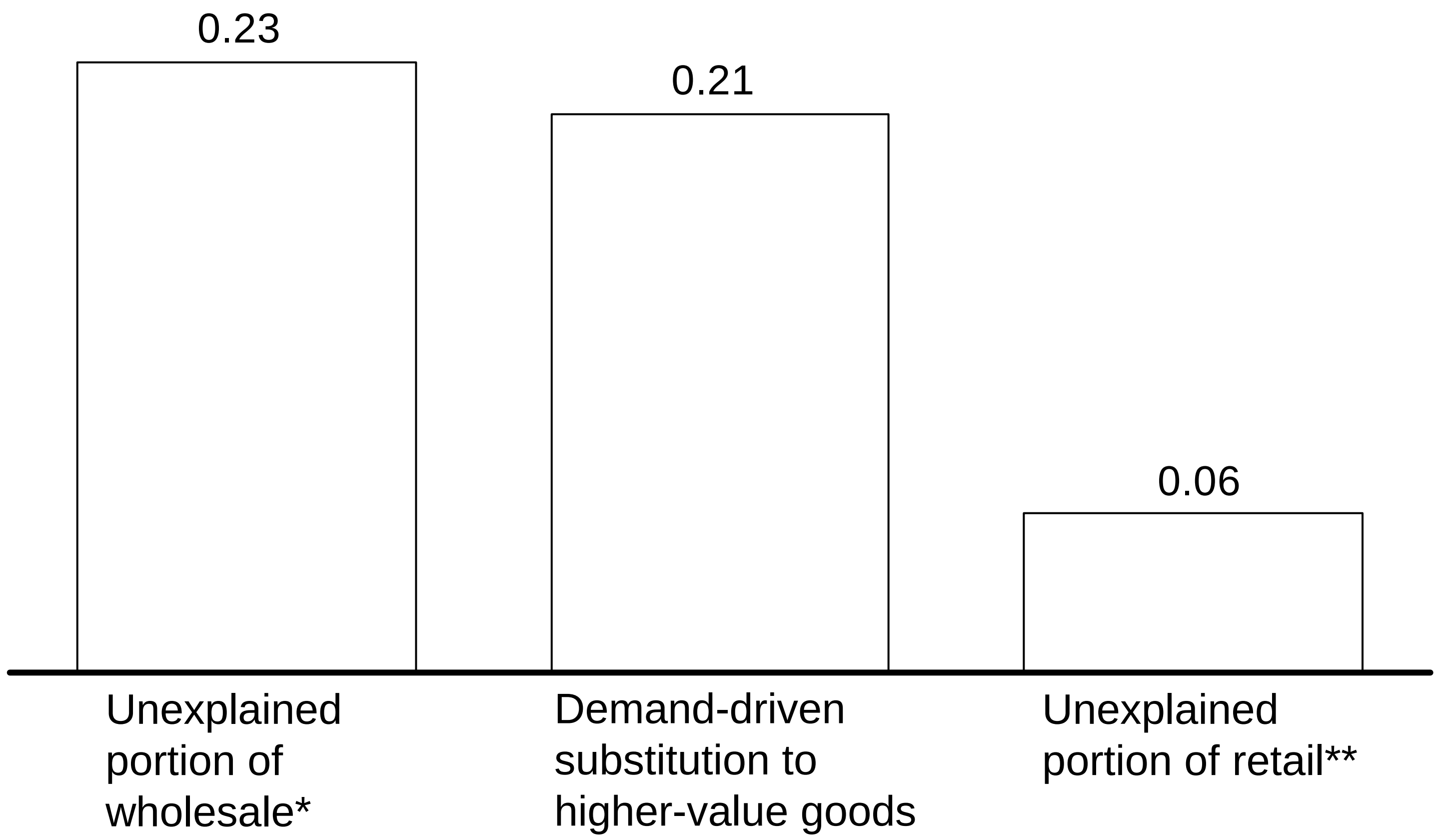


Source: MGI analysis

Exhibit 7

SOURCES OF UNCERTAINTIES AND THEIR POTENTIAL IMPACT

CAGR, contribution



* Outside warehouse automation and identified substitution to higher value goods

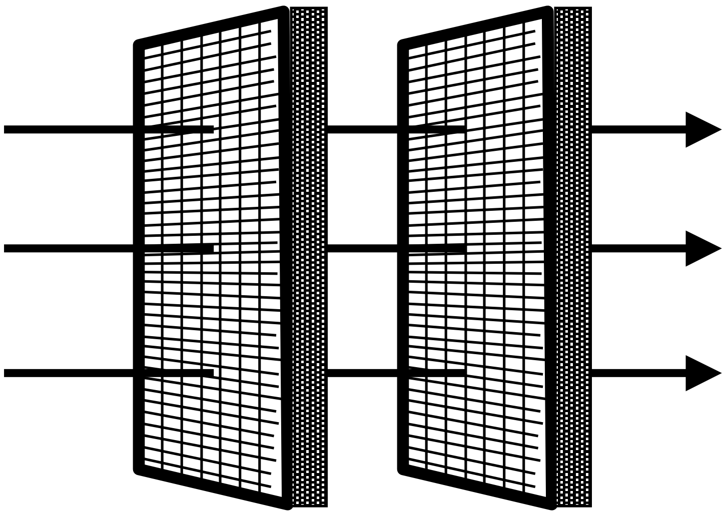
** Outside identified substitution to higher value goods and emergence of 'category killers' in certain product categories

Source: MGI analysis

Exhibit 8

SCREENING FOR LARGE, HIGH-ORGANIC GROWTH COMPANIES IN 1995 WOULD HAVE IDENTIFIED SEVERAL OF OUR INNOVATING FIRMS

Key firms in jumping sectors



Greater than $3.8 billion sales, 1995

Greater than 30% sales CAGR, 1990-95*

Compaq	Wal-Mart
Dell	Best Buy
Intel	Circuit City
Arrow Electronics	Office Depot
Merisel	Microsoft
Cardinal Health	Oracle
Home Depot	

30% market share in a market that is at least 1% of U.S. gross output

* Excludes companies that grew primarily through acquisition

Source: Compustat; BEA; MGI analysis

Exhibit 9

SCREENING FOR LARGE, HIGH-ORGANIC GROWTH COMPANIES IN 2000 IDENTIFIES 7 FIRMS OUTSIDE THE 6 JUMPING SECTORS

	Industry	Innovating firms*
6 jumping sectors	• Industrial machinery	• Dell, Cisco, Applied Materials
	• Electronic equipment	• Solectron, Flextronics, SCI Systems
	• Communications	• Nextel Communications
	• Wholesale	
	– Energy/gas trading	• Enron, Dynegy, Adams Resources, Plains Resources
	– Health care	• Cardinal Health
	– Computer equipment	• Ingram Micro, Tech Data Corp
	• Retail trade	• Home Depot, Kohl’s, The Gap, Staples
	• Securities	• Charles Schwab
Other sectors	• Insurance carriers	• Wellpoint Health Network
	• Business services	• Microsoft
	• Media/motion picture	• AOL TimeWarner
	• Depository institutions	• Wells Fargo, Washington Mutual
	• Nondepository institutions	• Capital One, Freddie Mac

Industries whose leaders grew primarily through acquisitions in order to leverage fixed labor

- Oil and gas exploration
- Food and kindred products
- Furniture and fixtures
- Chemicals and allied products
- Petroleum and coal products
- Transportation equipment
- Electric, gas, and sanitary services
- Insurance agents and brokers

* Firms with "Wal-Mart-like" size and growth: $5 billion sales in 2000 (30% of a market which is at least 1% of U.S. gross output) and 30% organic sales CAGR 1995-2000 (similar to Wal-Mart's 1990-95 CAGR)

Source: Compustat; BEA; MGI analysis

Exhibit 10

FOUR INDUSTRIES EXPERIENCED A RECENT REGULATORY CHANGE THAT COULD SPARK COMPETITION-INDUCED INNOVATION

[shaded box] Competition-promoting regulatory changes with medium-term impact

Industry*	Regulations encouraging competition
Health services	• Lower federal reimbursement creates need for efficiency improvement, but response will be slow
Trucking and warehousing	• Deregulated under Motor Carrier Act (1980); intra-state deregulation (1994); product deregulation (throughout 1990s); future impact unlikely
Depository institutions	• Effects of deregulation under DIDMCA (1980-82), product deregulation (throughout 1990s) and Riegle-Neil Interstate Banking Act (1994); Glass-Seagall Act repeal (1999)
Insurance carriers	• Recent success of state deregulation of auto insurance (S.C.) may continue; repeal of Glass-Seagall Act (1999)
Transportation by air	• Airline Deregulation Act (1978-82); productivity gains already realized
Chemicals and allied products	• Recent emphasis by FTC and Congress (e.g., "Drug Competition Act of 2001") on pharmaceutical industry may promote competition
Electric, gas, and sanitary services	• State deregulation of wholesale market and use of retail performance-based rate making will continue to promote efficiency

* Well-defined industries with approximately 1% of U.S. employment or more, excluding non-profit dominated sectors (education, social services, membership organizations)

Source: FTC; OECD; AEI-Brookings Joint Center on Regulatory Studies; MGI analysis

Exhibit 11

JUMPS IN THESE SECTORS WOULD LIKELY MAKE MODEST CONTRIBUTIONS TO AGGREGATE PRODUCTIVITY GROWTH

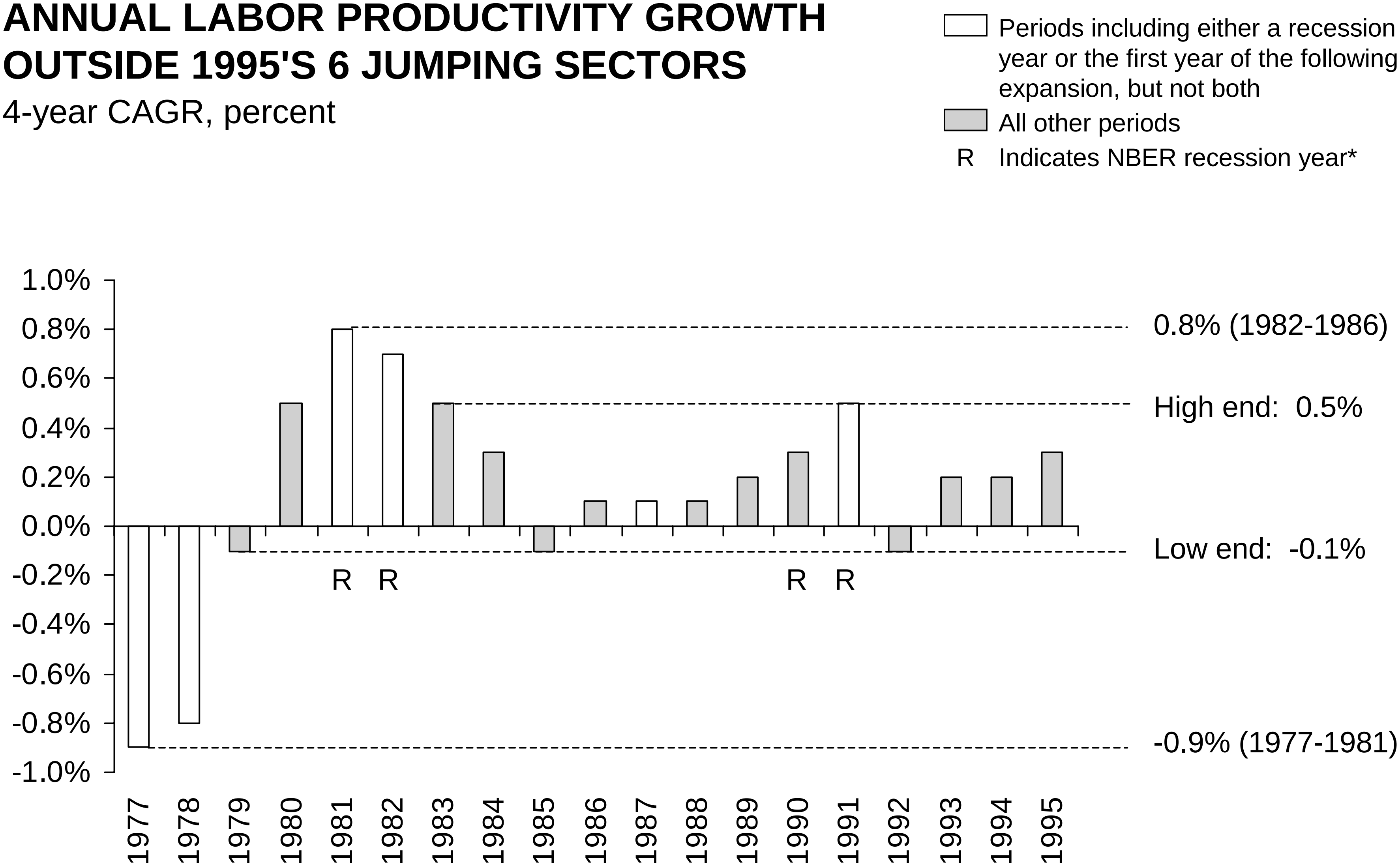
Industry	Relevant subsector	Triggering event	1999 Employment share	Contribution to aggregate productivity growth (assuming 3% sector jump)
Business services	Software publishers	Microsoft	0.26	0.01
Insurance carriers	All	Wellpoint Health, regulatory change	1.34	0.04
Printing and publishing	All	AOL-Time Warner	1.37	0.04
Motion pictures	All	AOL-Time Warner	0.58	0.02
Chemicals and allied products	Drugs	Regulatory change	0.22	0.01
Electric, gas, and sanitary services	All	Regulatory change	0.76	0.02
Depository institutions	All	Wells Fargo, Washington Mutual, regulatory change	1.70	0.05
Non-depository institutions	All	Capital One, Freddie Mac	0.61	0.02
			6.83	**0.21**

Source: BEA; U.S. Census; MGI analysis

Exhibit 12

ANNUAL LABOR PRODUCTIVITY GROWTH OUTSIDE 1995'S 6 JUMPING SECTORS

4-year CAGR, percent



* Does not include brief "dip" of Q1-Q2 1980 or Q4 1990 (beginning of 1991 recession)

Source: BEA, MGI analysis

Exhibit 13

POTENTIAL SCENARIOS FOR 2001-05 PRODUCTIVITY GROWTH*

CAGR

Jumping sectors' performance

		• Unexplained portion of retail and wholesale, shift to higher value goods are all unsustainable • No unusual jump in another sector	• Unexplained portion of retail and wholesale, shift to higher value goods are all sustainable • Unusual jump in another sector
Other sectors' performance	• Lower bound for productivity performance in the rest of the economy	1.6%	2.1%
	• Upper bound for productivity performance in the rest of economy	2.0%	2.5%

* Comparable to BLS productivity growth rate measure of 1.4% from 1987 to 1995 and 2.5% from 1995 to 2000

Source: MGI analysis

Exhibit 14

2001-05 PRODUCTIVITY GROWTH* DEPENDS ON 4 FACTORS

CAGR

Minimum sustainable level**		**1.6%**
If you believe that . . .	*. . . then add*	
1) . . . the rest of the economy will have an average productivity performance (instead of lower bound)	+ 0.2%	______
OR	**OR**	
. . . the rest of the economy will have an upper bound productivity performance	+ 0.4%	
2) . . . the unexplained portion of retail and wholesale is sustainable	+ 0.2% →	______
3) . . . the substitution to higher value goods is sustainable	+ 0.15% →	______
4) . . . an unusual productivity jump will occur in a particular sector (e.g., Internet, media)	+ 0.05% →	______
Sustainable productivity growth 2001-2005		**=** ______

* Comparable to BLS productivity growth rate measure of 1.4% from 1987 to 1995 and 2.5% from 1995 to 2000

** This minimum productivity growth rate assumes that the rest of the economy will have a lower bound productivity performance, the impact of emerging "category killers" in certain retail product categories is sustainable, the unexplained portion of wholesale and retail is unsustainable, the substitution to higher value good is unsustainable, and no additional unusual productivity jump will occur

Source: MGI analysis

Retail trade

SUMMARY

Retail trade contributed nearly one-fourth of the economy-wide productivity growth jump from 1987-95 to 1995-99 (0.31 percentage points of the 1.33 percentage point total). Understanding retail is thus critical to understanding the economy-wide acceleration in productivity growth.

When analyzing this sector, the McKinsey Global Institute focused in depth on general merchandise retailing. MGI also conducted focused analyses to understand the productivity impact of the rapid acceleration in the real value of computers and the emergence of the Internet as a sales channel.

In general merchandise (representing 16 percent of the total retail productivity growth acceleration), we found that Wal-Mart directly and indirectly caused the bulk of the productivity acceleration through ongoing managerial innovation that increased competitive intensity and drove the diffusion of best practice (both managerial and technological). We also found that external demand factors contributed meaningfully to the productivity acceleration, as consumers spent an increasing portion of their incremental income on higher-value goods (e.g., deciding to purchase a more expensive shirt rather than a less expensive one).

By contributing overwhelmingly to the productivity growth jump in general merchandise retail, Wal-Mart demonstrates the impact that managerial innovation and effective use of IT by individual firms can have on market structure, conduct, and performance.

Beyond general merchandise retail, MGI found that rapid innovation in semiconductors and computer assembly significantly benefited the retail sector, as retailers passed through computers of increasing quality to consumers (computer sales are included in the furniture and consumer electronics sector). Over 6 percent of the total productivity jump in retail trade was due to the 1995-99 acceleration in computer quality and performance. (This jump could thus arguably be accredited to the originating industries.)

In addition, the emergence of the Internet as a sales channel had a small but positive impact on retail productivity, contributing roughly 2 percent of the total retail productivity growth jump.

MGI also found that consumer substitution to higher value goods played a significant role in the retail sector as a whole, contributing 0.14 percentage points of the overall 0.31 percentage point jump (this substitution seems to be largely due to increases in consumer wealth and income rather than more effective efforts by retailers to change consumer behavior).

In general merchandise retail and furniture (the sector where computers are sold), at least half (0.04 percentage points out of the 0.09 percentage point contribution to the economy-wide productivity jump) of the productivity acceleration is likely to be sustainable over the next 5 years. The 0.01 percentage point contribution of the emergence of the Internet as a sales channel is also expected to be sustainable. Although the remainder of retail (which contributed 0.21 percentage points to the economy-wide productivity jump) was not examined in detail, MGI determined that an additional 0.03 percentage points was due to the emergence of “category killers” (i.e., players that are significantly more productive than average and quickly growing share) and is likely to be sustainable. Combining these results, MGI thus finds that at least 0.08 and at most 0.31 percentage points of the economy-wide productivity jump is likely to be sustainable over the next 5 years.

INTRODUCTION

Because of both its large size and its large jump in labor productivity growth, retail trade contributed nearly one-quarter of the economy-wide productivity growth jump. MGI focused its analyses in retail on an in-depth study of the general merchandise subsector and two other targeted analyses that were used to determine the impact of the sale of higher-value computers and the emergence of business-to-consumer Internet sales.

Importance of retail trade to the overall question

Retail trade contributed 0.31 percentage points to the overall US productivity jump of 1.33 percentage points, as measured by MGI.[1] This is the largest contribution of any sector in the economy apart from wholesale trade, which contributed 0.37 percentage points (Exhibit 1).

- ¶ The main contribution of retail trade to the aggregate US productivity growth jump came from within-sector productivity growth rather than from shifts in employment share between sectors.
- ¶ Over the time period examined by MGI, retail trade increased its labor productivity growth rate by 4.3 percentage points (from 2.0 percent to 6.3 percent per year, 1987-95 versus 1995-99).
- ¶ The sector's IT capital intensity growth rate[2] has accelerated substantially in real terms (a 12.6 percentage point acceleration in annual growth rates, 1995-99 versus 1987-95), reflecting in part the increased capability and quality that a given dollar of IT spending represents (Exhibit 2).

Profile of retail trade sector

Retail trade represents 11 percent of private sector employment and 7.7 percent of total value added (GDP) in the US economy. This makes it the largest sector studied by MGI (Exhibit 1).

1 The Bureau of Economic Analysis (BEA) calculates value added only for retail trade and restaurants combined. MGI uses the BEA methodology to calculate productivity for retail trade alone and for seven subsectors of retail trade. The data used when calculating retail's contribution to the overall productivity jump includes restaurants and thus arrives at a different contribution than that presented here (0.34 percentage points rather than 0.31).

2 Defined as real IT capital per employee. As IT capital intensity is only available for retail and restaurants combined, combined figures are presented here.

Retail trade consists of 7 subsectors that vary widely in terms of both sales and value added (Exhibit 3).

Retail trade and restaurants is not a particularly IT-intensive sector, with only $1,106 of IT capital per worker in 1996 versus an economy-wide average of $6,177[3].

Scope of study

To allow a more in-depth understanding of the causes of the productivity growth jump, MGI narrowed the scope of its analysis by focusing on general merchandise retail, which represents 14 percent of 1999 nominal sales and contributed 16 percent of retail trade's productivity growth acceleration (Exhibit 4). Studying general merchandise also allowed us to focus our efforts on the retail subsector that was hypothesized to have the most advanced and productive use of IT.

In addition, MGI conducted two focused analyses to understand the impact of innovation in semiconductors and computer manufacturing on retailers and to estimate the productivity impact of business to consumer Internet sales.

Measurement and data sources

Several measurement complexities (which are well known to both academics and government agencies) exist in retail. When examining retail, MGI used the same approach as that employed by the Bureau of Economic Analysis (BEA). Although imperfect, this methodology is the best way to measure retail productivity and is more than adequate when comparing growth rates between periods.

Measurement issues in retail revolve around the fact that the retail sales deflator has three important characteristics:

¶ It is based on the retail consumer price index (CPI) and thus does not adjust for changes in service level within formats (e.g., convenience, location, customer service, length of lines), making real sales an imperfect measure of the output of a retail establishment. Implicitly, the assumption is made that service at a given retailer is proportional to the value of goods offered.

¶ It implicitly assumes that price differentials between stores reflect differences in service levels. The continuing share gain of low-priced,

[3] Again, because IT intensity data is only available for retail and restaurants combined, combined figures are presented here.

"big box" formats (i.e., large stores) indicates, however, that service levels at these stores may not be as low as prices suggest.

- It does not fully take differential rates of inflation between stores (and thus formats) into account due to its use of a multiyear cycle to update the basket.

As the BEA uses the retail sales deflator to deflate nominal gross margin, all of these issues also flow through to the measurement of real value added and thus productivity.

Even combined, however, the potential biases introduced by these errors are small and unlikely to introduce a meaningful error in period-to-period comparisons (as the errors are likely to be similar between periods).

The US Census, the BEA, and the US Bureau of Labor Statistics (BLS) all collect data on retail trade. These three agencies, however, only gather sufficient data to allow subsector value-added calculations in Census years. The data limitation required MGI to make estimates of subsector value added and productivity between Census years (see Appendix A for methodological notes).

GENERAL MERCHANDISE SUBSECTOR

From 1995-99, general merchandise retailers doubled their productivity growth rates (to 10.1 percent per year from an already high 4.8 percent per year) and contributed 16 percent of the total retail productivity growth jump. The productivity growth jump in this subsector was primarily due to heightened competitive intensity (due to the continued growth of Wal-Mart) and increased consumer substitution toward higher-value goods.

Link with aggregate productivity growth jump

General merchandise contributed 0.05 percentage points to the economy-wide productivity growth jump (Exhibit 4).

- The productivity growth jump in general merchandise is due entirely to increases in labor productivity growth within the subsector rather than changes in employment share between sectors.
- Although productivity in general merchandise was growing at 5.3 percent per year from 1987-95, the growth rate nearly doubled from 1995-99, averaging 10.1 percent per year and resulting in a delta of 4.8 percent (Exhibit 5).

Subsector profile

The subsector represents a sizeable portion of overall retail (with 14 percent of total retail sales, 16 percent of total hours worked, and 15 percent of retail value added) (Exhibit 4).

The dominant players in general merchandise retail are large, big box formats: Wal-Mart, KMart, Target, Costco, and Sears. Together, these 5 players represent 60 percent of 1999 sales and 52 percent of 1999 employment (Exhibit 6).

Labor productivity performance

Labor productivity growth in general merchandise jumped from 5.3 percent from 1987-95 to 10.1 percent from 1995-99. MGI's labor productivity calculation for general merchandise uses real value added as an output measure, requiring the assumptions noted in Appendix A. Input is based on the labor hours of all general merchandise employees as reported by the BLS.

IT intensity is unknown at the subsector level in retail, but overall IT intensity growth in retail and restaurants jumped from 6.3 percent to 18.9 percent over the time periods studied.

Disaggregating the productivity jump into jumps in real sales per hour and jumps in value added per unit of real sales allowed us to further focus our research efforts.

¶ The labor productivity growth jump in general merchandise is primarily caused by an increase in the growth rate of real sales per hour (rather than an increase in the growth rate of value added per unit of real sales). The total productivity growth jump of 4.8 percentage points disaggregates into a 3.2 percentage point jump in the growth of real sales per hour and a 1.5 percentage point jump in the growth of value added per unit of real sales (Exhibit 5).

¶ For the remainder of our analysis of general merchandise, MGI focused on the causes of the real sales per hour jump rather than the jump in value added per unit of real sales. Although this limited us to explaining only 70 percent of the productivity jump, it allowed us to work with a physical quantity: real sales. It also freed us from overly relying on the assumptions embedded in subsector value-added measures (again, see Appendix A for details on subsector value-added measurement).

Causality in general merchandise

Managerial innovation and its diffusion through heightened competitive intensity was the key factor at work in this subsector, as shown in the causality analysis in

Exhibit 7. Between 1987 and 1995, Wal-Mart maintained a sizeable productivity advantage over other general merchandise players and significantly increased its sales share. After 1995, the remainder of the market (particularly smaller players) responded aggressively to emulate
Wal-Mart's best practices, improve their own productivity, and slow Wal-Mart's share gain. At the same time, the subsector was significantly impacted by shifts in consumer demand, as consumers increasingly substituted to higher-value goods.

Firm-level ("operational") factors

At the firm level, the real sales per hour jump was primarily driven by accelerating improvements in the organization of functions and tasks (OFT), some of which were IT-enabled, and by the consumer substitution to, and retailer pass-through of, higher-value goods. Scale also played a role, as increased sales per square foot (due in part to the continued emergence of supercenters) contributed to the jump by allowing firms to leverage their fixed labor (Exhibit 8).

Pass through of higher-value goods[4]. Real sales growth can occur due to an increase in the number of units or an increase in the real revenue per unit. The latter occurs when consumers change their consumption patterns and substitute to goods of higher value. Acceleration in the growth rate of real revenue per unit (average price per unit deflated by the appropriate price index) contributed 1.4 percentage points to the general merchandise sales per hour growth rate jump (Exhibit 9).

This acceleration in the growth rate of real revenue per unit translates into an increase in sales per hour only if the service model/required labor input of the higher-value good (toward which consumers are substituting) is identical to that of the original good. To control for this, our analysis measures only within category price evolution at a high level of granularity (e.g., the impact within butter price changes are captured, but the impact of substitution from butter to higher-value margarine is excluded). In addition, we control for the price impact of format mix evolution between periods. Thus, the productivity impact as stated is conservative and can be effectively considered a lower bound.

Given that the real revenue per unit methodology only measures substitutions to higher-value goods that are very unlikely to require additional store labor (i.e., as

4 Although less clear than the sales per hour impact, substitution to higher-value goods also carries through to value-added productivity. Conceptually, consumers benefit more from receipt of a higher-value good, meaning that retailers providing such a good have provided higher service and thus output. Empirically, there is no clear relationship in general merchandise between the value of goods sold and the gross margin percent – a wide dispersion exists both within and across product categories of different values. Thus, goods of higher sales value will also have higher gross margins (and thus value added). Substitution to higher-value goods also increases value-added productivity by leveraging the fixed portion of purchased services.

we measured average price changes only within narrow product categories), the increase in real revenue per unit of 1.4 percentage points flows directly through to an increase in real sales per hour. Thus, consumer substitution to higher-value goods explains one-third of the total within firm improvements in sales per hour (taking into account the negative impact from the mix shift between firms).

Scale effects, via the leverage of fixed labor, contributed 0.5 percentage points of the 3.2 percentage point total jump in real sales per hour growth.

¶ The emergence of supercenters, with higher unit sales per square foot than traditional discount stores, contributed 0.1 percentage points to the scale effect (Exhibit 10).

¶ A more important factor on a delta basis was that the growth rate of units sold per square foot in non-supercenter discount stores (nominal sales per square foot divided by average price per unit) accelerated by 1.2 percentage points between 1987-95 and 1995-99 (from 1.9 percent to 3.1 percent per year) (Exhibit 11).

¶ Based on an analysis of the tasks performed by store employees, MGI estimated that approximately 40 percent of store labor is fixed relative to units (primarily price change workers, sales/customer service employees, and headquarter/store management employees) (Exhibit 11).

¶ The acceleration in unit sales per square foot coupled with this portion of fixed store labor translates into a 0.4 percentage point acceleration in the growth rate of real sales per employee.

Changes in the mix of firms between periods contributed -0.9 percentage points to the productivity growth jump, according to MGI estimates. That is, as more productive players (e.g., Wal-Mart) gained share less rapidly, their contribution due to above average productivity levels and market share gains was less in the second period than the first (although positive in both) (Exhibit 12).

Improvements in OFT, some of which are enabled by the use of IT, contributed the remainder of the productivity acceleration (2.3 percentage points).

Although improvements in OFT can take many forms, a number of improvements seem to have been most significant during the time period examined by MGI:

- ¶ A more extensive use of cross-docking and better flow of goods/ palleting to maximize in-store labor efficiency (enabled by eSCM or other electronic supply chain management tools[5])
- ¶ The use of forecasting tools to better align staffing levels with demand
- ¶ Redefining store responsibilities and cross-training employees (e.g., pooling of labor across aisles and organization of tasks such as price changes on functional rather than departmental level)
- ¶ Improvements in productivity measurement and utilization rates at check-out.

While the first two of these examples are enabled by IT, the second two are the result of continual process improvement and managerial innovation. Looking broadly at the subsector and the estimated productivity benefits of the above examples, we estimate that IT enabled roughly one-half of the combined OFT/ IT contribution.

MGI conducted an extensive firm-level analysis of the sources of within-firm operational improvements and found that Wal-Mart directly contributed one-third of the total sales per employee growth jump. A turnaround effort at Sears and Target's explicit emulation of Wal-Mart contributed meaningfully to the growth jump beyond Wal-Mart. Interestingly, however, smaller firms (e.g., Meijer, Kohls, MacFrugals) contributed almost all of the remaining improvement, as they reacted to remain viable in the face of Wal-Mart (Exhibit 13).

Industry-level/external factors

Wal-Mart gained market share very rapidly between 1987 and 1995, leading to heightened competitive intensity and the later (post-1995) diffusion and adoption of best practices. The overall macro-economic environment also changed post-1995, leading consumers to increasingly substitute to higher-value goods in the face of buoyant stock markets (e.g., income and wealth effects) and high consumer confidence.

Emergence of Wal-Mart. Since its founding in 1962, Wal-Mart has developed a business model based on several key managerial innovations:

[5] eSCM is the use of electronic information flows to optimize supply chain performance (e.g., by sharing information with suppliers, providing real-time access to stock and flow of goods, or automating replenishment orders).

- **Big box format.** Wal-Mart was a pioneer in the development of the big box, or large store format. This larger format generated labor economies of scale at the store level and also allowed Wal-Mart stores to carry a wider range of goods than competitors.

- **Every day low pricing (EDLP).** Wal-Mart aggressively competed on price and built its value proposition almost exclusively on this basis (particularly early on in its growth). This created a virtuous cycle of scale-driven efficiency and share gain. As its sales volume grew, Wal-Mart was able to gain cost advantages due to scale (at the network level) and increasing negotiating power with suppliers. Passing on part of this cost advantage to consumers in the form of lower prices fueled further share gain, beginning the cycle again.

- **Efficiency in logistics.** Wal-Mart quickly assumed its own distribution function and since then has continued to assume or eliminate the role of wholesalers wherever possible. In addition, Wal-Mart expanded geographically around its distribution centers (in a hub and spoke pattern), keeping logistics costs low.

Wal-Mart has also been distinctive in its use of IT to improve its business processes and cost position. It is widely regarded as the leader in the use of IT in retail and pioneered a number of IT applications, for example:

- Early adoption of computers to track inventory in distribution centers (1969)

- Use of computer terminals in stores to facilitate communication (1977)

- Scanning using UPC codes (1980)

- Groundbreaking use of electronic data interchange (EDI) (1985)

- Satellite communications network (1987)

- Use of radio frequency (RF) guns (late 1980s)

- Expansion of the EDI system to include an extranet, which became an early form of eSCM (beginning in 1991)

- Development of “Retail Link”, a micro-merchandising and supply chain management tool (beginning in 1991).

As with its managerial innovations, these innovative uses of IT improved Wal-Mart’s productivity (both capital and labor) and cost position. They also resulted in continued market share gain due to their contribution to lower prices, lower out of stocks, and more effective merchandising.

Competitive intensity. The managerial innovations mentioned above gave Wal-Mart a 44 percent productivity gap relative to the remainder of the market in 1987 and allowed the firm to grow its sales share from 9 percent in 1987 to 27 percent in 1995 (Exhibit 14). By 1995, that gap had widened to 48 percent. Between 1995 and 1999, however, other players responded and closed Wal-Mart's productivity gap to 41 percent (Exhibit 14). This market reaction also led to a slowdown in Wal-Mart's share gain – limiting it to 3 percentage points between 1995 and 1999.

Retailers responded to the increase in competitive pressure around 1995 by reducing headcounts and making substantial process and productivity improvements:

¶ Arthur Martinez became CEO of Sears in 1994 and began a major turnaround effort, divesting noncore (and non-general merchandise) businesses and making significant reductions in headcount (estimated at over 10 percent of general merchandise employees).

¶ The vice-chairman of Target, Gerald Storch, has publicly stated (in the Economist) that Target is the "world's premier student of Wal-Mart," reflecting the unique impact that the market leader has had on shaping industry conduct.

¶ Smaller general merchandise firms (e.g., Meijer, MacFrugals) collectively increased their sales per employee growth rate by almost 8 percent after 1995 and also rely on efficient "big box" formats.

Macroeconomic factors. Sales growth in retail naturally comes from both growth in the number of units sold and growth in the real revenue per unit sold. The latter accounted for almost two-thirds of the acceleration in retail sales growth (Exhibit 15).

¶ During 1995-99, consumer purchasing power increased and consumers chose to substitute more to higher-value goods rather than purchase more units. This substitution contributed 1.4 percentage points to the general merchandise sales per hour growth rate jump (Exhibit 9).

¶ MGI believes that retailers did not significantly induce the substitution to higher-value goods (i.e., the effect was primarily driven by demand rather than supply). Although general merchandisers are continually trying to improve the mix of products that they sell, we found no evidence that their efforts were more successful in the second period than the first. Some powerful micro-merchandising tools did become functional around 1995, but interviews with industry experts indicate that 1995-99 was more a period of gathering merchandising data rather than using it to more effectively influence consumer behavior.

- Although MGI does not believe that supply factors related to consumer substitution to higher-value goods changed substantially after 1995, it is difficult to ascribe a cause to this change in consumer behavior with any certainty. We believe, however, that extraordinary external factors such as GDP growth, surges in personal disposable income, and higher consumer confidence played a role in driving the growth in real revenue per unit.

Sustainability

We estimate that between 0.02 and 0.05 percentage points of the 0.05 percentage point contribution to value-added productivity growth is likely to be sustainable over the next 5 years.

- The baseline contribution of general merchandise (1987-95) is assumed to be entirely sustainable, as we have no reason to believe that it will increase or decrease.
- We believe that the 0.024 percentage point contribution of improvements in OFT is entirely sustainable, as the overall subsector only recently responded to Wal-Mart, and the Wal-Mart productivity gap to the remainder of the market remains large (Exhibit 16).
- The contribution of scale net of the negative mix effect (-0.004 percentage points) is also likely to be sustainable, as it is the result of continuing shifts in market structure and dynamics.
- We also believe that some of the 0.014 percentage point contribution of substitution to higher-value goods is sustainable, although we do not predict the extent to which consumers will substitute to higher-value goods in the future. Thus, we leave the sustainable portion of the substitution to higher-value goods entirely a range.
- 0.016 percentage points of the historic productivity improvement remains unexplained (the acceleration in the growth of value added per unit of real sales). As a lower bound, we assume that all of the unexplained portion is unsustainable. As an upper bound, we assume that all of the unexplained portion is sustainable.

Combining the above estimates results in a range of sustainable contribution to overall productivity growth of 0.02 to 0.05 percentage points. MGI is not able to analyze this issue with the rigor that it used when studying the historic causes of the productivity growth jump and therefore leaves the sustainable portion of the general merchandise improvement a fairly broad range.

Finally, this range does not take into account possible discontinuities in managerial or technological innovation (e.g., the advent of self-check out or a new wave of format evolution), either of which could further accelerate productivity growth in the subsector.

THE PRODUCTIVITY IMPACT OF SELLING MORE POWERFUL COMPUTERS (FURNITURE AND CONSUMER ELECTRONICS SUBSECTOR)

MGI found that the sale of more powerful computers contributed roughly 1.4 percent of the economy-wide productivity growth jump (as retailers passed through goods of higher value without having to significantly change the required labor per good).

Scope

Our analysis in furniture and consumer electronics was targeted to understand the impact that the acceleration in the growth of computing power (and thus in the real value of a given dollar of spending on computers) had on retail productivity.

Since the consumer benefit from the retail function is proportional to the value of goods purchased, the pass-through of higher-value computers represents a real increase in value added and thus productivity (assuming that no additional labor is required).

Results and methodology

To isolate the impact of the sale of more powerful computers on retail productivity, we decomposed and then recast the gross margin and value-added deflators (in furniture and consumer electronics, the subsector in which computers are sold) holding the growth rate of the computer and software price deflator constant between periods (Exhibit 17). Thus, we are able to estimate what productivity growth in the subsector would have been without the acceleration in the rate of computer quality improvements (as changes in quality are reflected in the deflators). The difference between our re-cast productivity growth and the productivity growth as actually measured represents the productivity impact of selling computers of higher quality.

Without the accelerating decline of the computer deflator, furniture and consumer electronics would have experienced a productivity growth jump of 4.6 percentage points (rather than the 8.9 percentage points actually observed) (Exhibit 18). The sale of computers thus contributed 6 percent of the retail productivity growth jump and 1.4 percent of the economy-wide productivity growth jump.

Ascribing the jump in labor productivity to the pass through of higher-value computers implicitly makes the assumption that computers of higher value do not require more labor to sell (an assumption that has been confirmed by discussions with industry experts).

Sustainability

The 0.02 percentage point contribution to overall productivity growth due to the pass through of higher-value computers is sustainable to the extent that computers continue to improve in quality at the 1995-99 rate. Our analysis indicates that the productivity contribution of the sale of computers is sustainable over the next 5 years, as computers and semiconductor improvements should continue at or above the 1995-99 rate (although a negative mix shift could exist in the future as employment growth in this subsector slows).

THE IMPACT OF THE EMERGENCE OF THE INTERNET AS A SALES CHANNEL (MISCELLANEOUS SUBSECTOR)

MGI found that the emergence of the Internet as a sales channel contributed roughly 2 percent of the overall retail productivity growth jump.

Scope

Our analysis in miscellaneous retail was targeted. The goal was to understand the impact that the emergence of the Internet as a sales channel had on the subsector.

Results and methodology

The emergence of the Internet as a sales channel contributed 12 percent of the miscellaneous sales per hour jump (equivalent to roughly 2 percent of the overall retail productivity growth jump).[6]

MGI calculated the impact of the Internet by assessing the relative productivity and share of Internet retailers versus "brick and mortar" (traditional) firms.

The key factor behind the low contribution of Internet sales is low penetration – market share in 1999 was still quite low at only 2.4 percent of total miscellaneous sales and 0.4 percent of total retail sales in 1999.

[6] This contribution assumes that on-line retailers are twice as productive as traditional nonstore retailers (based on an examination of the characteristics of leading on-line retailers). Our finding is not very sensitive to this assumption. Because sales are known and employment is arrived at by modifying productivity assumptions, the employment share of Internet retailers decreases as their productivity increases, limiting their possible contribution.

Sustainability

The 0.01 percentage point contribution to overall productivity growth due to the growth of Internet commerce is sustainable to the extent that penetration of the Internet continues to grow at or above 1995-99 rates. Our analysis indicates that the productivity contribution of the Internet is entirely sustainable over the next 5 years, as Internet sales are forecast to gain share at least as quickly as was observed from 1995-99.

OVERVIEW OF RETAIL AS A WHOLE

MGI found that IT is likely to have contributed between 20 and 40 percent of the productivity jump in overall retail. As much of retail was not studied in detail by MGI, we do not attempt to estimate overall retail sustainability. Instead, we provide a lower bound for sustainability based on the sectors that we did study in depth (0.08 percentage points out of the overall retail contribution of 0.31 percentage points) and an assessment of emerging trends in other sectors.

Contribution of IT to retail beyond the general merchandise subsector (GMS)

As MGI did not scrutinize any other retail subsector with the same level of rigor it applied to general merchandise, it is not possible to specify with precision what caused the productivity growth jump beyond general merchandise (apart from the targeted analyses on computers and business-to-consumer Internet sales). Two factors, nevertheless, enable us to significantly narrow the range of potential causality. Our specific focus in doing so, given the overall project's objectives, was to understand how large or small IT's role could have been in the remainder of the retail productivity acceleration.

For the rest of retail, MGI has conducted key aggregate analyses including:

- Subsector-level disaggregation of the total productivity jump into a jump in real sales per hour and a jump in value added per unit of real sales
- Subsector-level assessments of the degree to which a substitution toward higher-value goods took place
- Subsector-level assessments of the extent to which significant business or technological innovation took place (e.g., the emergence of "category killers," expansion of new formats, and the discontinuity presented by the growth of the Internet).

This analysis provides a framework by which to estimate the sources of the productivity acceleration for retail as a whole.

MGI has thus been able to narrow the range of potential causality with two distinct but consistent methods.

- Method 1: Use GMS as an upper bound of the impact of IT (Exhibit 19).
    - Our research indicates that general merchandise firms are the most successful and advanced retailers in their use of IT.

- Given this, we can assume that the GMS experience with IT provides an upper bound for other retail sectors.

- This method yields a reasonable range of 15 to 35 percent of the retail jump due to IT, with an upper bound of 50 percent.

¶ Method 2: Apply aggregate analyses based on consumer substitution to higher-value goods (Exhibit 20).

- Estimate the retail-wide substitution to higher-value goods (using average price and index data covering 75 percent of retail sales).

- Subtract the contribution of substitution to higher-value goods from the overall retail productivity growth jump.

- As an upper bound, assign the remaining jump in sales per hour growth entirely to IT (a more likely split is 50 percent of the jump, as a number of IT-independent OFT improvements can be identified[7]) and assume that changes in value added per unit of sales growth not traceable to substitution to higher-value goods are not IT related.

- This method yields a reasonable range of 15 to 30 percent of the retail jump due to IT, with an upper bound of 45 percent.

Combining these results, a reasonable range of IT contribution is approximately 15 to 35 percent of the total productivity growth jump.

Sustainability in retail as a whole

We estimate that at least 0.08 and at most 0.31 percentage points of retail's 0.31 percentage point contribution to the overall productivity acceleration is sustainable over the next 5 years[8].

¶ The lower bound of 0.08 percentage points comes from combining our estimates of the minimum sustainable contribution of general merchandise (0.02), the pass-through of higher-value computers (0.02), the growth of the Internet as a sales channel (0.01), and an estimate of the impact of emerging "category killers" (i.e., players that are significantly more productive than average and quickly growing share) in sectors of retail beyond general merchandise (0.03).

7 The fact that IT likely contributed at most 50 percent of the OFT improvement in general merchandise and that Wal-Mart is an unquestioned IT leader within the retail sector suggests that attributing 50 percent of OFT improvements in retail as a whole is an upper bound.

8 The baseline contribution of general merchandise (1987-95) is assumed to be entirely sustainable, as we have no reason to believe that it will increase or decrease.

- An additional 0.14 percentage point contribution is attributable to substitution to higher-value goods (including the impact of purchased services leverage). This effect is demand driven and partially sustainable, although we do not predict the extent to which consumers will substitute to higher-value goods in the future. Thus, we leave the sustainable portion of the substitution to higher-value goods entirely a range.

- The remaining contribution of retail (0.09 percentage points) of the retail productivity improvement has not been studied in detail and remains entirely a range.

Combining the above estimates results in a range of possible sustainable contribution to productivity between 0.08 and 0.31 percentage points. MGI is not able to analyze this issue with the rigor that it used when studying the historic causes of the productivity growth jump and therefore leaves the sustainable portion of the improvement beyond general merchandise a fairly broad range.

Finally, this range does not take into account possible discontinuities in managerial or technological innovation (e.g., the advent of self-check out or a new wave of format evolution), either of which could further accelerate productivity growth.

APPENDIX A: ESTIMATING SUBSECTOR VALUE ADDED AND PRODUCTIVITY

Because the BEA measures value added only at the level of retail as a whole, MGI was forced to create estimates of value-added productivity at the subsector level. To create these estimates, we used the following methodology:

¶ Gross margin is available annually at the subsector level from the BEA. We used this data as our starting point.

¶ To arrive at nominal value added, we must subtract an estimate of purchased services per subsector from the subsector gross margin. The US Census provides subsector purchased services in Census years (every 5 years). Given this, nominal value added is available every 5 years at the subsector level. To arrive at value added for inter-Census years, we linearly interpolate between Census years, and linearly extrapolate from the 1997 Census figures to arrive at an estimate for 1999. In addition, we normalize the interpolation/extrapolation by using the annual BEA purchased services total (in effect, this gives us a control total and significantly more comfort in the subsector estimates) (Exhibit 21).

¶ We then construct a value-added deflator at the subsector level by constructing a Fisher index for each sector (using the same methodology as the BEA).

¶ Our labor inputs at the subsector level are hours, provided by the BLS.

CONFIDENTIAL

Exhibits for Retail Write-Up

MGI NEW ECONOMY

Write-up

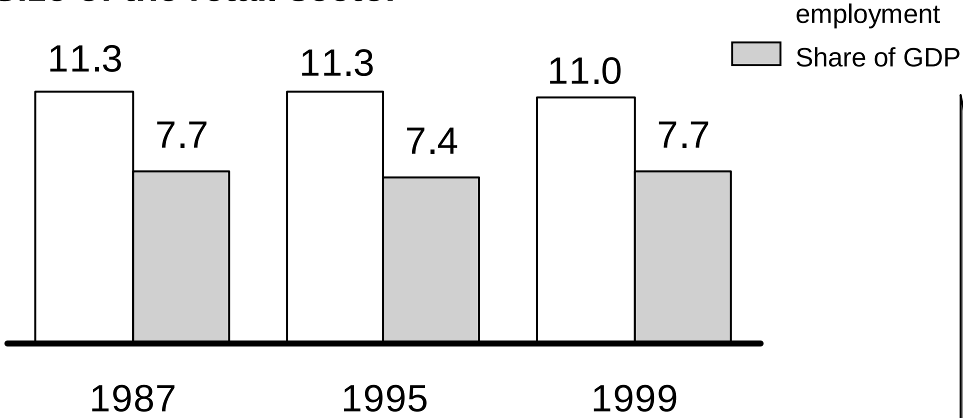
October 1, 2001

Exhibit 1

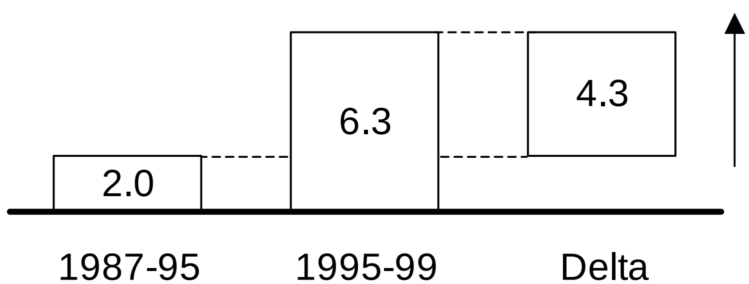
RETAIL TRADE HAS A LARGE EMPLOYMENT SHARE AND IS THE SECOND LARGEST CONTRIBUTOR TO U.S. PRODUCTIVITY GROWTH ACCELERATION

Percent

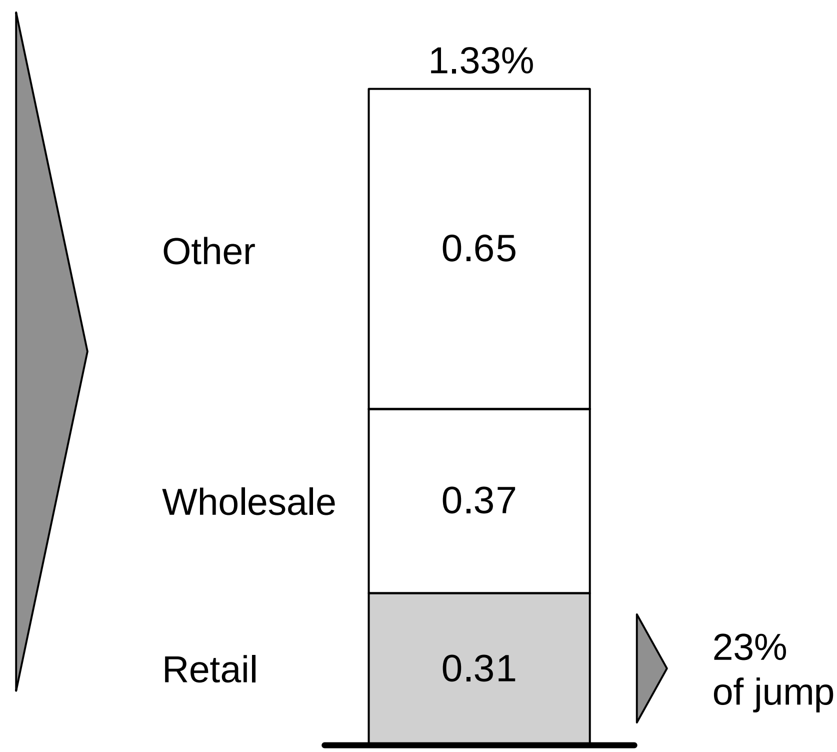
Size of the retail sector



Retail value added productivity growth



Productivity acceleration, 1987-95 vs. 1995-99
CAGR



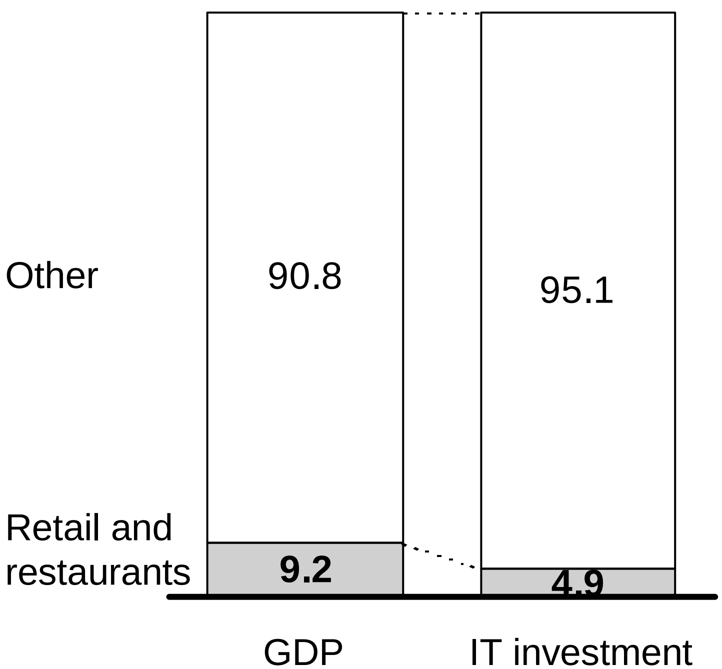
* Value added per hour

Source: BEA; MGI analysis

Exhibit 2

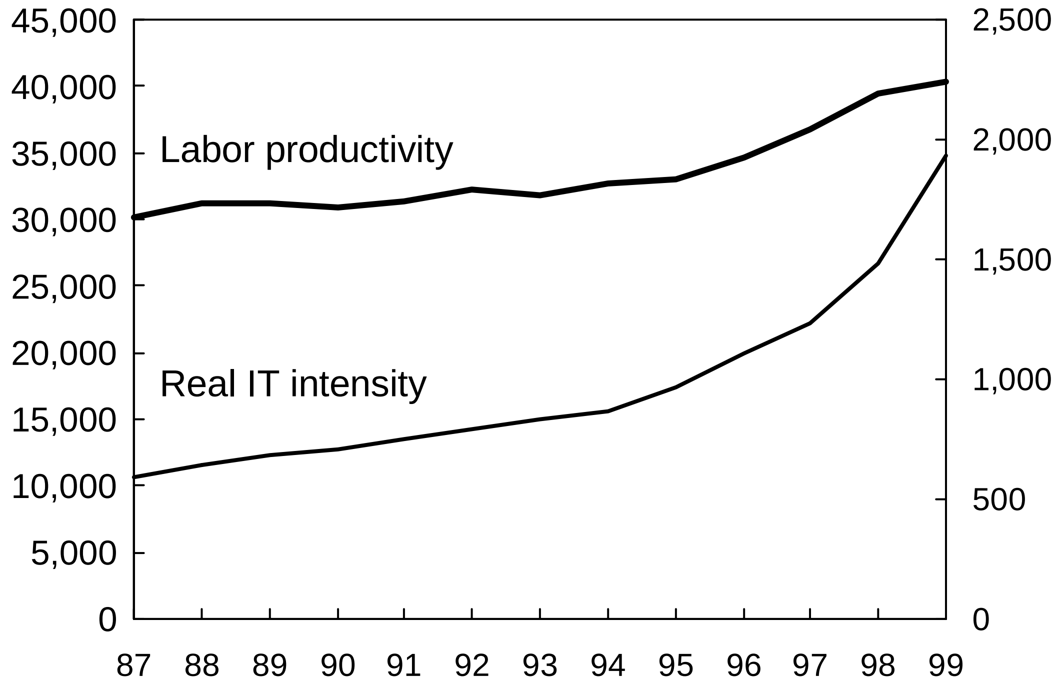
RETAIL AND RESTAURANT'S SHARE OF IT IS HALF OF GDP SHARE, BUT IT INTENSITY GROWTH ACCELERATED AFTER 1995

1999 share of GDP and IT investment
Percent



Labor productivity GPO* over PEP**

Real IT capital intensity Real IT capital over PEP



	CAGR 1987-95 Percent	**CAGR 1995-99** Percent
IT capital intensity	6.3	18.9
Economy-wide IT capital intensity	6.0	13.9

* GPO: Gross product originating (value added)
** PEP: Persons engaged in production (labor input)
Note: IT capital intensity is only available for retail trade and restaurants combined – this page presents that data
Source: BEA; MGI analysis

Exhibit 3

RETAIL TRADE CONSISTS OF 7 DISTINCT SECTORS

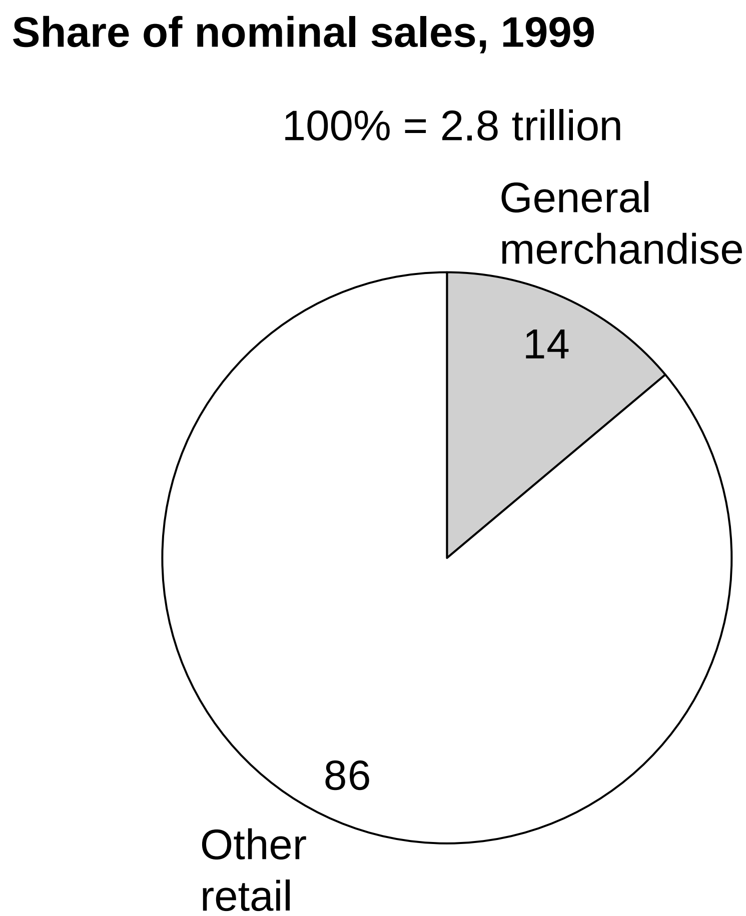
Sector	1999 sales $ Billions	1999 value added $ Billions	Firm-level examples
Automotive dealers and gasoline service stations	961	174	• Pep Boys • Auto Nation
Miscellaneous retail	482	167	• Toys "R" Us • CVS • Amazon.com • Tiffany & Co.
Food stores	472	124	• Albertsons • Safeway • 7-Eleven
General merchandise	410	105	• Wal-Mart • Sears • Kmart
Building materials	193	54	• Home Depot • Lowes
Furniture and consumer electronics	172	46	• Circuit City • Jennifer Convertibles
Apparel	144	44	• GAP • Nordstrom • Limited
Total retail	**2,834**	**714**	

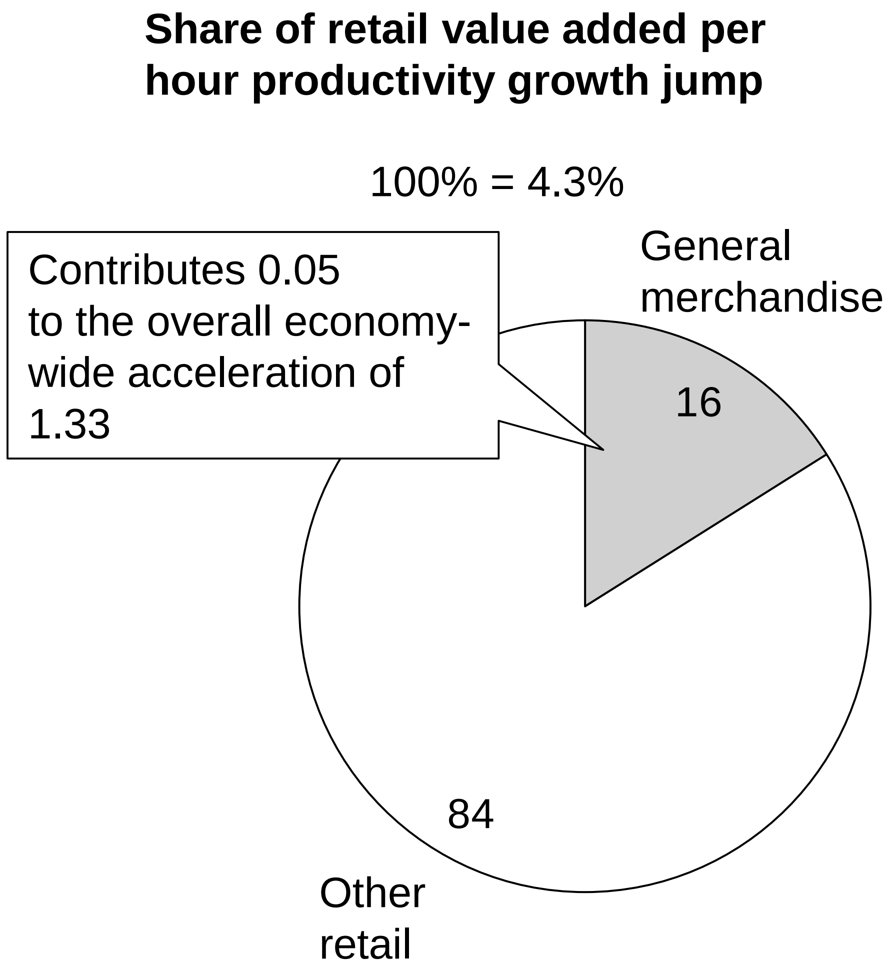
Source: BEA; BLS; Census; Compustat

Exhibit 4

GENERAL MERCHANDISE IS A SIGNIFICANT PORTION OF RETAIL

Percent



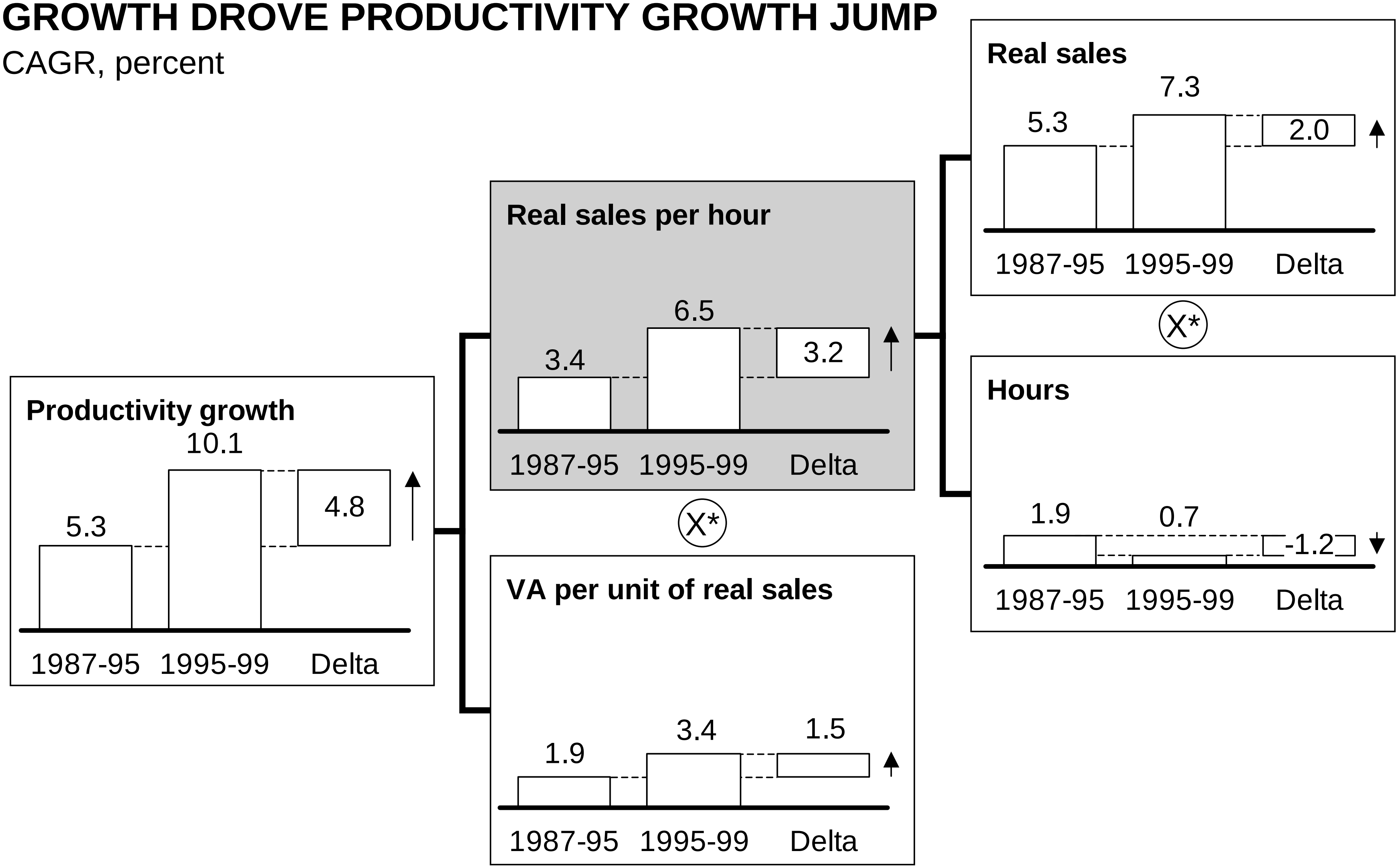


Source: BEA; U.S. Census; MGI analysis

Exhibit 5

ACCELERATION OF REAL SALES PER HOUR GROWTH DROVE PRODUCTIVITY GROWTH JUMP

CAGR, percent



* Calculation is (1 + growth rate one) * (1 + growth rate two)

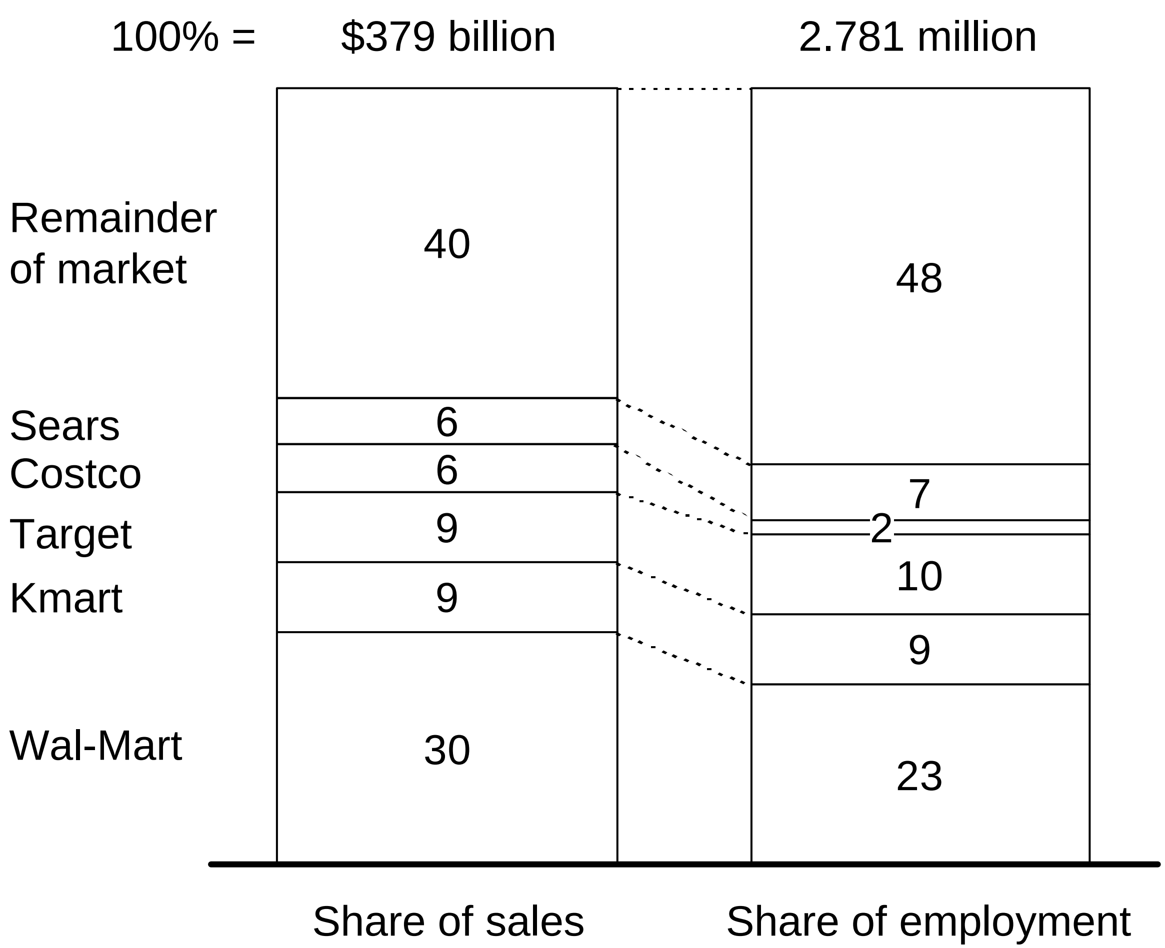
Note: The real sales per hour delta does not total due to rounding

Source: BEA; BLS; Census; MGI analysis

Exhibit 6

THE GENERAL MERCHANDISE MARKET IS CONCENTRATED

Percent, 1999



Source: Annual reports; 10Ks; Compustat; Census; BEA; BLS

Exhibit 7

CAUSALITY ANALYSIS EXPLAINS 1995-99 JUMP IN GENERAL MERCHANDISE PRODUCTIVITY

● Important (>50% of acceleration)

◑ Somewhat important (10-50% of acceleration)

○ Not important (<10% of acceleration; asterisk to right indicates significant negative)

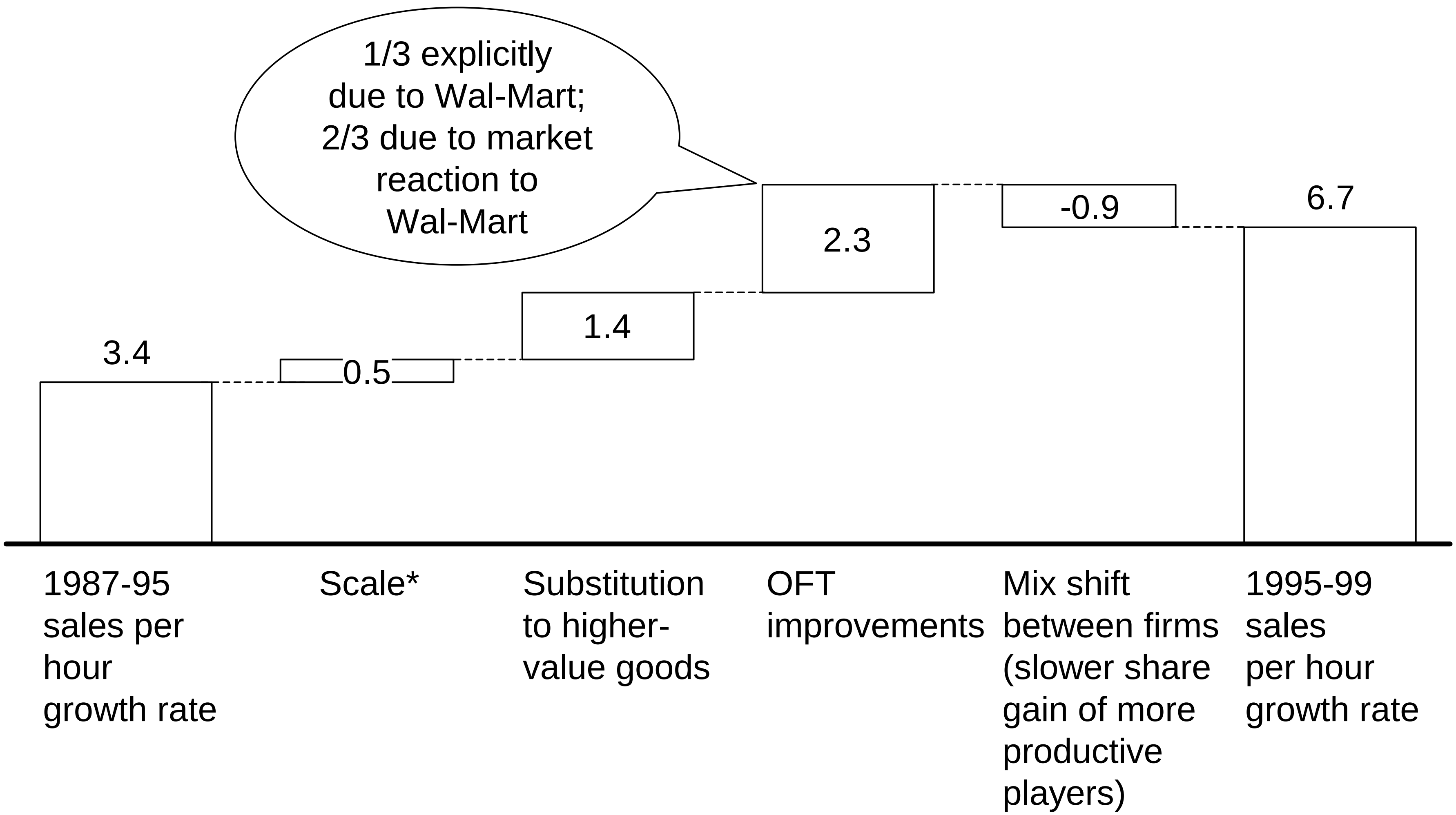
External factors	• Demand factors (macro-economic/financial markets)	●	Income/wealth effect and consumer confidence leading to increased spending, a portion of which is on higher-value goods
	• Managerial and technological innovation	●	Wal-Mart innovation (half managerial and half technological)
	• Product market regulation	X	
	• Up/downstream industries	X	
	• Measurement issues	X	
Industry dynamics	• Competitive intensity	●	Emergence of clear productivity leader with significant scale (Wal-Mart) leading to higher competitive intensity
	• Prices/demand effects	X	
Firm-level factors	• Output mix	X	
	• Capital/technology/capacity	X	
	• Intermediate inputs/technology	●	Consumer substitution to higher-value goods
	• Labor skills	X	
	• Labor economies of scale	◑	Leverage of fixed labor due to increased unit sales per square foot
	• OFT/Process design	◑	Significant OFT improvements post-1995 (reaction to Wal-Mart)

Source: Interviews; MGI analysis

Exhibit 8

4 FACTORS AFFECTED THE THROUGHPUT GROWTH JUMP IN GENERAL MERCHANDISE

CAGR, percent



* Increased scale due to growth in size of traditional discount formats and emergence of supercenters

Note: Numbers do not total due to rounding

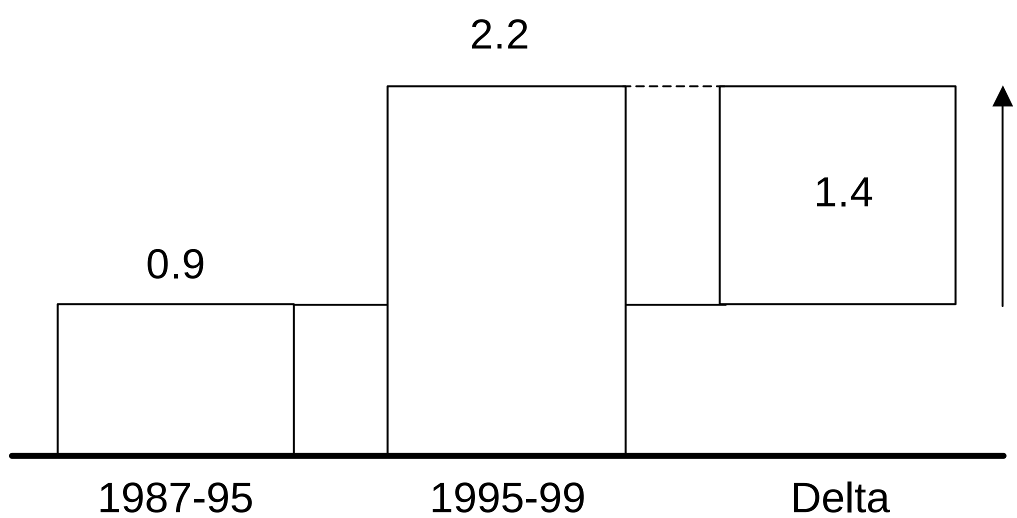
Source: MGI analysis

Exhibit 9

SUBSTITUTION TO HIGHER-VALUE GOODS CONTRIBUTED 1.4 PERCENTAGE POINTS TO THE THROUGHPUT GROWTH JUMP IN GENERAL MERCHANDISE

CAGR, percent

Real contribution of substitution to higher-value goods (within same format, at detailed category level)



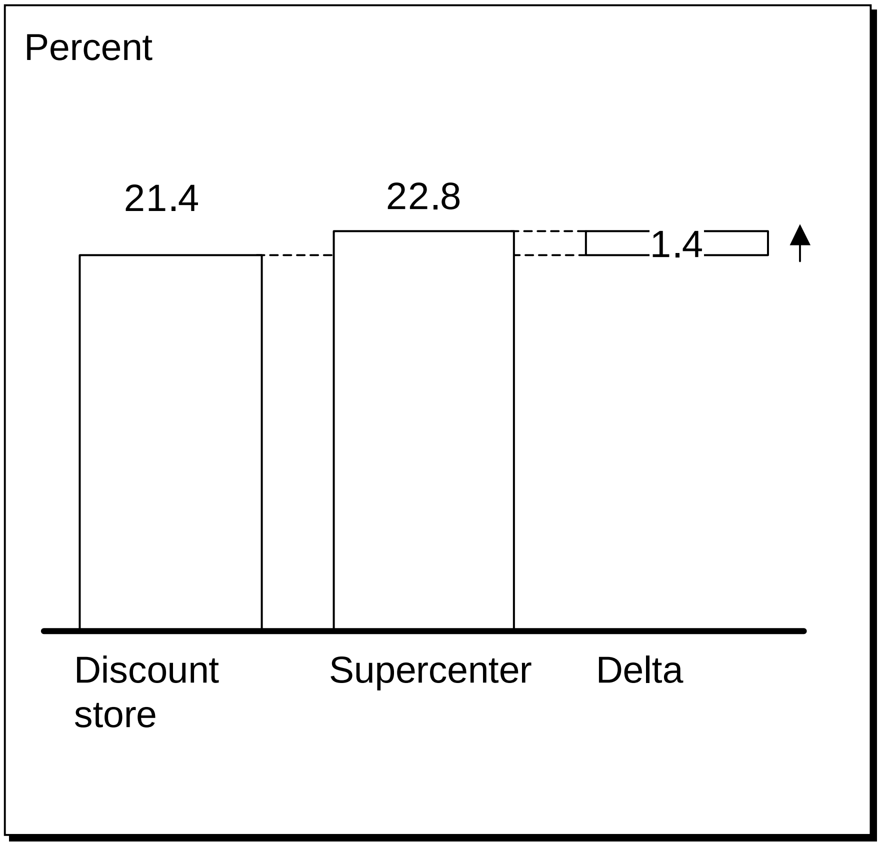
Note: After adjusting for format mix shift (+0.27 and +0.21) and estimated formula bias in sales deflators (+0.40 and +0.40); numbers do not total due to rounding

Source: NPD; IRI; IMR; BEA; BLS; U.S. Census; MGI analysis

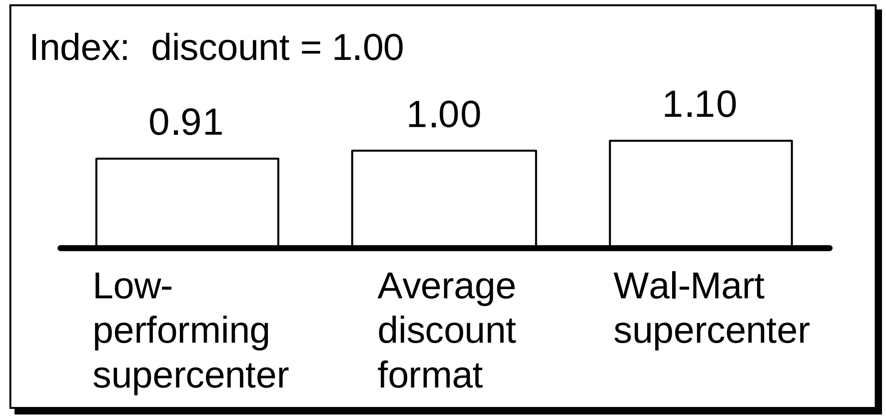
Exhibit 10

SUPERCENTERS DELIVER HIGHER CAPITAL PRODUCTIVITY BUT THEIR LABOR PRODUCTIVITY IMPACT IS SMALL

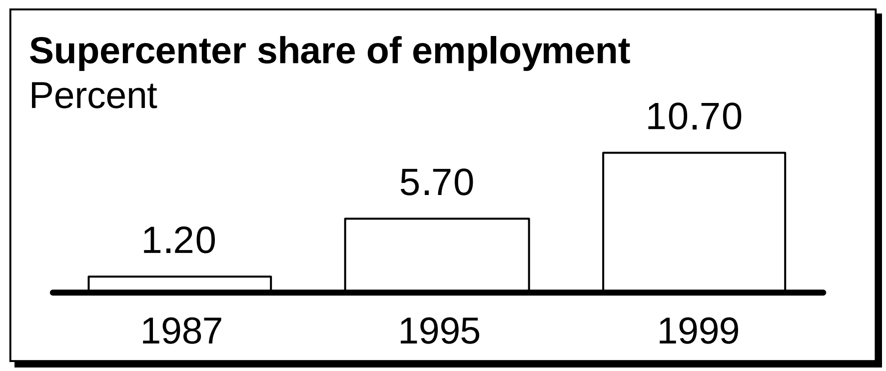
ROIs* are higher . . .



. . . but labor productivity varies due to differences in staffing models . . .



. . . and penetration is low



Net contribution of 0.1%

* Estimated pre-tax ROI for Wal-Mart

Source: Analyst reports; McKinsey interviews; MGI analysis

Exhibit 11

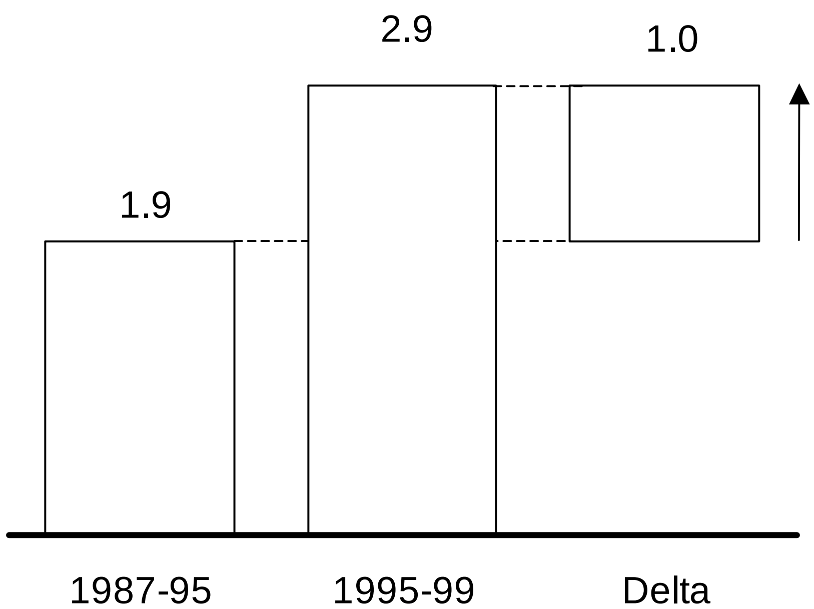
INCREASED UNIT SALES PER SQUARE FOOT LEVERAGES FIXED LABOR

Percent

MGI estimate used

Growth in units per square foot*

CAGR



Range of potential impact

Percentage of labor fixed relative to units**	Productivity gain due to leverage of fixed labor
50	0.5
40	0.4
30	0.3

* Sample of 5 firms representing 58% of 1999 sales

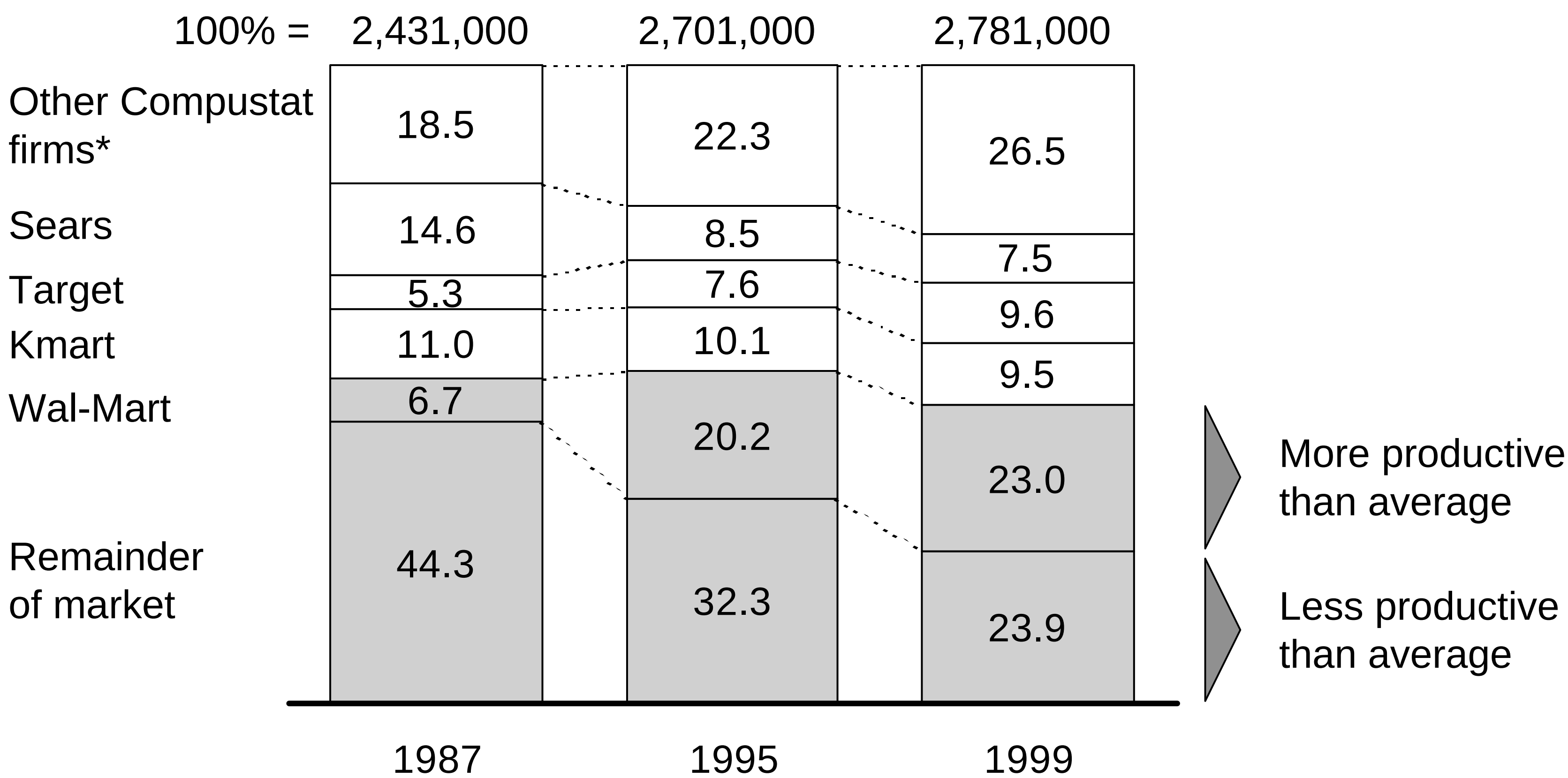
** E.g., portions of HQ, sales/customer service, price changes and signage, cashier (payment time)

Source: NPD; IRI; IMR; BEA; annual reports; 10Ks; MGI analysis

Exhibit 12

CHANGES IN MARKET SHARE HAVE BEEN SIGNIFICANT AND HAVE LED TO A NEGATIVE MIX SHIFT CONTRIBUTION

Number of employees; percent



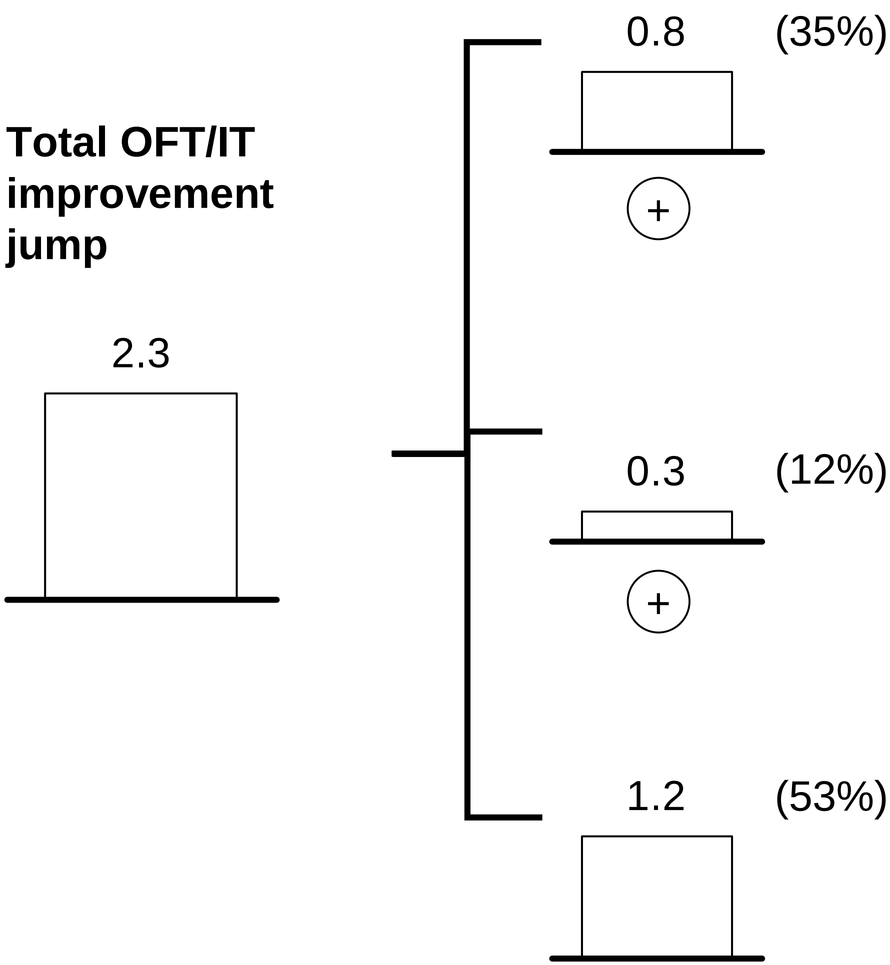
* Market share growth due to small individual contributions of a number of firms

Source: BLS; Census; 10Ks; Compustat; annual reports; MGI analysis

Exhibit 13

WAL-MART CONTRIBUTES DIRECTLY OR INDIRECTLY TO ALMOST ALL OF THE OFT/IT IMPROVEMENT JUMP

Percent



Wal-Mart contribution

- Moderate improvement in throughput coupled with large size

Other large firm contribution

- Turnaround at Sears
- Continued improvement at Target and Kmart
- Partially offset by declines at Service Merchandise and Federated

Smaller firm contribution

- Reaction to Wal-Mart leads to significant improvement in throughput
- Large improvements in throughput and increased size of Meijer

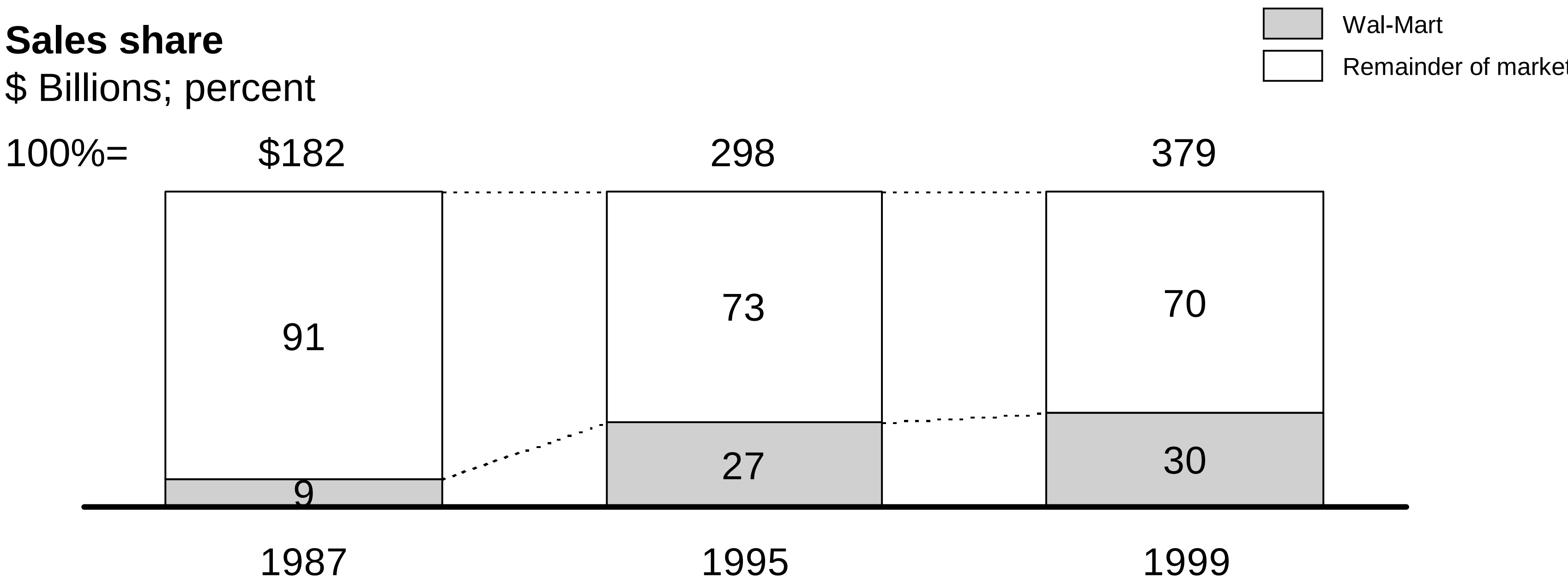
Source: MGI analysis

Exhibit 14

WAL-MART IS MORE PRODUCTIVE AND IS GAINING SALES SHARE

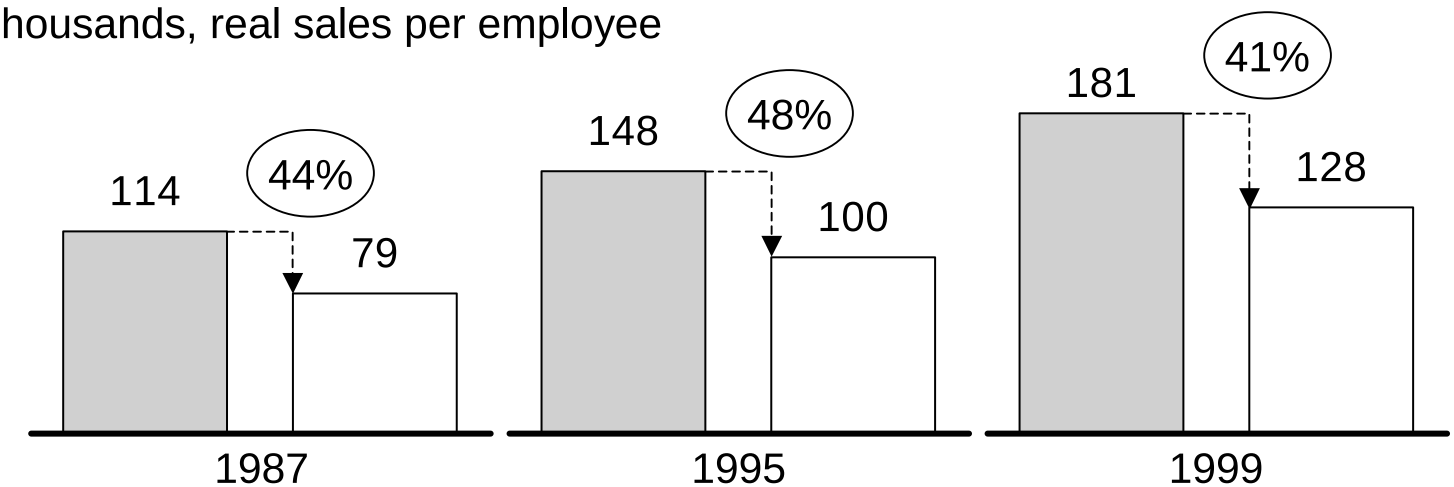
Sales share

$ Billions; percent



Productivity levels

$ Thousands, real sales per employee

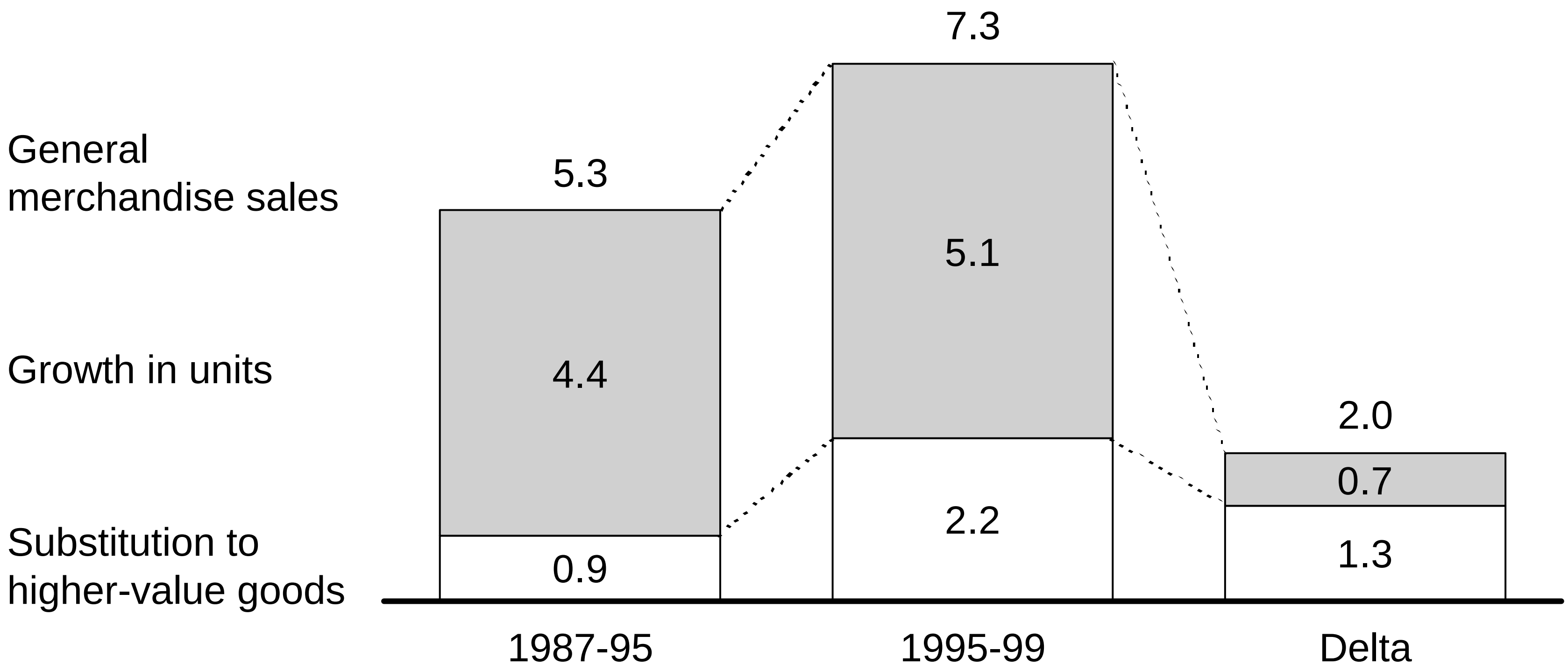


Source: BEA; U.S. Census; 10Ks; annual reports; MGI analysis

Exhibit 15

GENERAL MERCHANDISE SALES HAVE GROWN DUE TO INCREASES IN BOTH UNITS AND REVENUE PER UNIT

CAGR, percent



Source: MGI analysis

Exhibit 16

MUCH OF THE OFT IMPROVEMENT FROM 1995-99 IS LIKELY TO BE SUSTAINABLE

Percent

	Remains at 1999 level	Closes at 1995-99 rate	Closes at twice 1995-99 rate	Wal-Mart OFT improvement, 1999-2004
1987-95 rate	2.7	3.5	4.2	**2.7%**
Midpoint of rates	3.1	3.9	4.6	**3.1%**
1995-99 rate	3.4	4.2	4.9	**3.4%**
Productivity gap, 2004	**41%**	**34%**	**28%**	

If Wal-Mart grows at midpoint of 1987-95 and 1995-99 rates and market closes productivity gap at 1995-99 rate, OFT improvement will be 3.9 (vs. 4.3% 1995-99)

Exhibit 17

COMPUTERS DETERMINE DECLINE RATE OF FURNITURE AND CONSUMER ELECTRONICS GROSS MARGIN DEFLATOR

CAGR, percent

	Contribution to deflator		
	1987-95	1995-99	Delta
Furniture stores	0.33	0.28	-0.05
Floor covering stores	0.22	0.31	0.10
Other home furnishings stores	0.05	-0.05	-0.11
Household appliance stores	0.04	-0.08	-0.12
Radio, TV, and computer stores	-1.14	-5.23	-4.09
Music stores	-0.24	-0.25	-0.01
Total	**-0.71**	**-4.99**	**-4.29**

- The radio, TV, and computer sub-sector determines rate of price decline and changes in rate of price decline
- Computers determine 65% of the radio, TV, and computer sub-sector decline

Source: BEA; MGI analysis

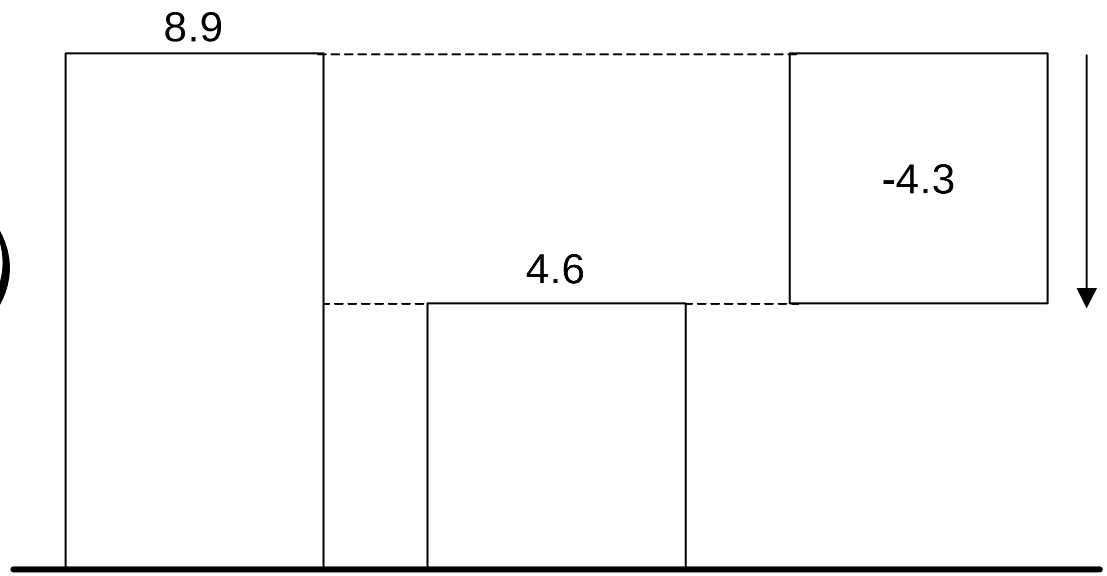
Exhibit 18

HALF OF THE PRODUCTIVITY GROWTH JUMP IN FURNITURE AND CONSUMER ELECTRONICS IS DUE TO THE COMPUTER SUBSECTOR

Productivity acceleration within furniture and consumer electronics

Real value added per hour

Assuming that it requires no additional labor to sell higher value computers



	Productivity acceleration as measured	Productivity acceleration with adjusted computer deflator*	Delta
Contribution to overall retail productivity	0.59 (14%)	0.30 (8%)	0.29 (6%)

* Adjusted such that rate of change of computer deflator is constant

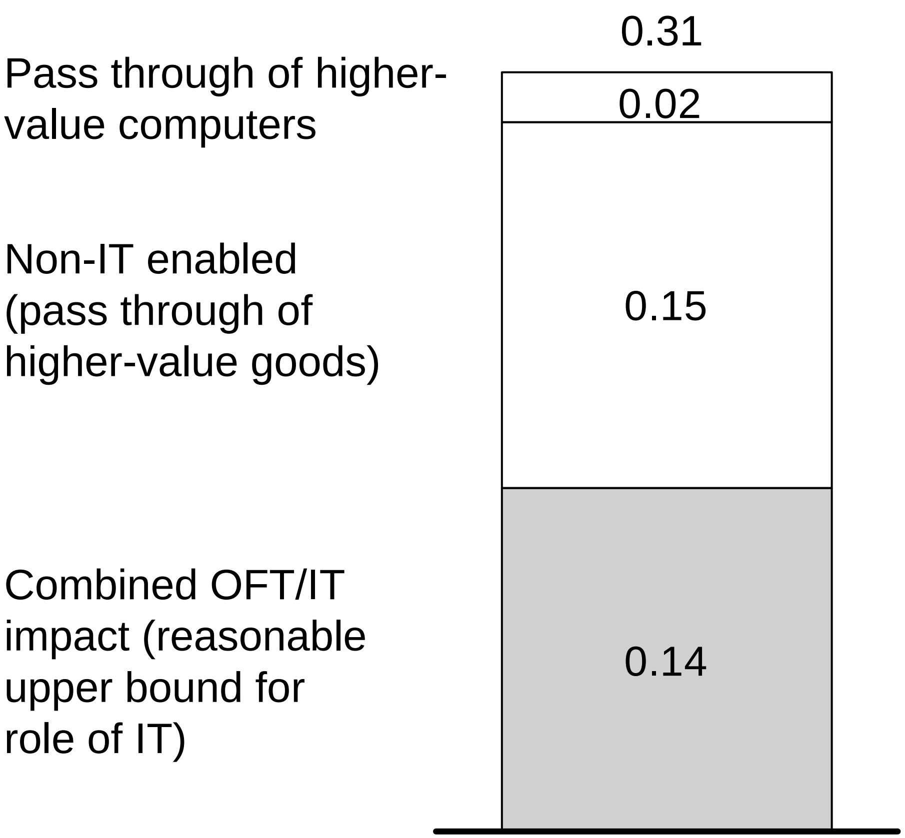
Source: BEA; BLS; MGI analysis

Exhibit 19

METHOD 1: AT MOST, HALF OF THE RETAIL JUMP WAS DRIVEN BY IT – USING GMS EXPERIENCE AS AN UPPER BOUND

Retail contribution to overall productivity jump

Percent



Assumptions (implicit or explicit)

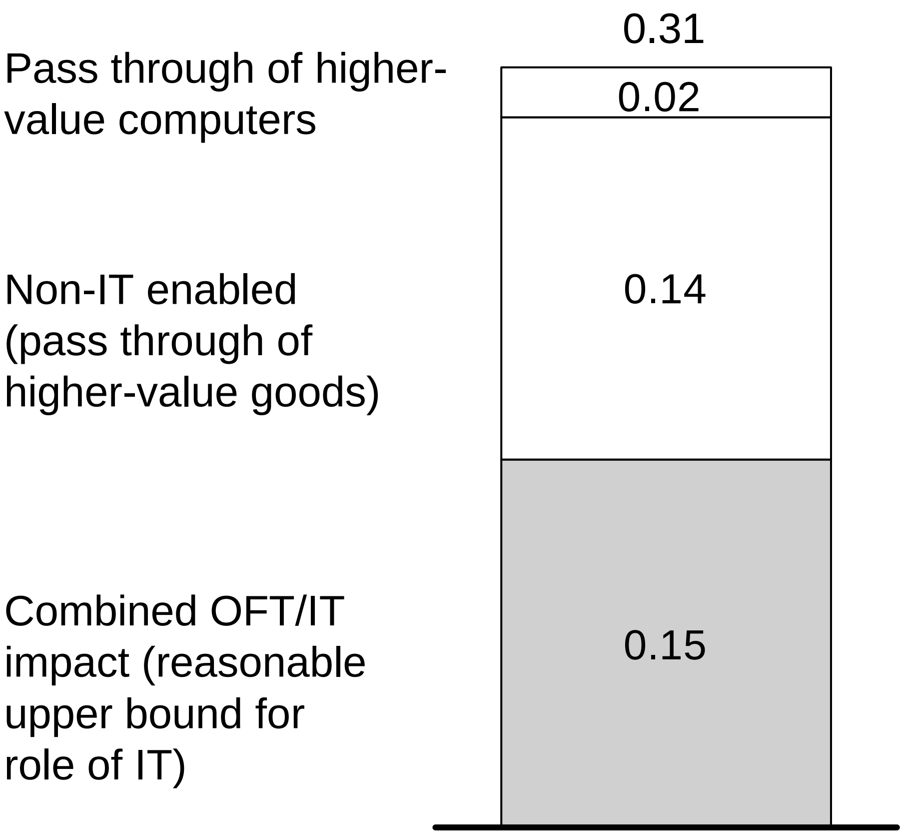
- Substitution to higher-value goods is entirely demand driven
- Substitution to higher-value goods is similar within and beyond GMS
- GMS experience is similar to that of retail as a whole (e.g., scale, mix shift, etc.)

Source: MGI analysis

Exhibit 20

METHOD 2: AT MOST, HALF OF THE RETAIL JUMP WAS DRIVEN BY IT – SUBTRACTING IMPACT OF SUBSTITUTION TO HIGHER-VALUE GOODS

Retail contribution to overall productivity jump
Percent



Assumption (implicit or explicit)

Substitution to higher-value goods is entirely demand-driven

Source: MGI analysis

Exhibit 21

METHODOLOGY BY WHICH MGI CALCULATES RETAIL PRODUCTIVITY AT THE SECTOR LEVEL

1. Estimate nominal value added at sector level

Nominal gross margin from BEA
– Nominal purchased services

= Nominal value added

- Allocate total retail purchased services to sectors using nominal PS/sales ratio from Census
- Linearly interpolate Census PS/sales ratio between 1987-92 and 1992-97; extrapolate it from 1997-99
- Normalize to yearly BEA total purchased services

2. Build value-added deflators at sector level using BEA data and MGI estimates

- Use BEA nominal gross margin
- Use MGI allocation of BEA purchased services
- Apply MGI gross margin deflator using BEA methodology
- Apply BEA overall purchased services deflator

- Use BEA subsector data to create Fisher indexed gross margin deflator for retail sectors

Wholesale trade

SUMMARY

The wholesale trade sector is one of the largest sectors in the US economy, accounting for 6.2 percent of employment and 7.9 percent of GDP in 1999. It is also a very heavy user of IT, having almost twice the IT capital per worker as other sectors in the economy. Wholesale trade experienced dramatic productivity growth in the latter part of the 1990s from 2.9% to 8.2%. It is the sector that contributed the most to the acceleration of productivity growth (0.37 percentage points of the 1.33 percentage point total) in the US after 1995.

In spite of the importance of this sector, lack of data makes a comprehensive analysis of productivity growth impossible. We therefore focused in depth on pharmaceuticals wholesaling, where we could find data from the trade association (the National Wholesale Druggists' Association, or NWDA) on distribution center activity, which is the traditional wholesaling activity.

In pharmaceuticals, we found that productivity grew faster after 1995 as compared to 1990-95. Half of the acceleration was driven by warehouse automation and improvements in the organization of functions and tasks association with sector consolidation. The other half was due to an increase in the value of the pharmaceutical wholesalers' intermediation role associated with the increase in value (in real terms) of the drugs they distribute. This substitution towards higher value drugs was ultimately driven by accelerated R&D and marketing efforts of manufacturers.

Similar trends also occurred in other subsectors of wholesaling: move to higher-value added services, consolidation, warehouse automation, and substitution to higher-value goods (for at least the portion of sales directed at retailers). We estimated the impact of warehouse automation across the rest of wholesale in order to develop a view on the sustainability of productivity growth in the latter period for the sector as a whole. We find that at a minimum 15% of the 1995-99 productivity growth in wholesale will be sustainable. This estimate is based on our analysis of the pharmaceutical wholesale sector as well as the applicability of warehouse automation and does therefore not comment on the sustainability of other factors which may have been present in other subsectors of wholesale.

Wholesale trade

INTRODUCTION

Wholesale trade is the largest contributor of any sector in the US economy to the productivity growth jump in 1995-99. It is therefore critical that we understand what has driven this increase in growth (from 2.9% to 8.2%) as well as the degree to which it will be sustainable in the years to come.

OVERVIEW OF THE WHOLESALE TRADE INDUSTRY

Wholesale trade is a very large and fragmented sector. It represents approximately 6.2 percent of private sector employment, 7.9 percent of GDP (Exhibit 1) and 13.2 percent of IT investment in the US economy (Exhibit 2).

Industry profile

The nature of wholesaling has changed dramatically in the past decade (Exhibit 3). Wholesalers have evolved from providing very basic distribution services to engaging in a whole host of new activities ranging from manufacturing to consulting to sales and marketing. However, we believe that for the most part the BEA (United States Government Bureau of Economic Analysis) does not capture these new activities, which are likely to be classified in other sectors such as business services and manufacturing. We therefore focus our efforts on understanding the traditional role of the distributor.

The census defines 18 different subsectors in wholesale, none of which accounts for more than 15 percent of total sales or employment (Exhibit 4). The census also splits wholesalers into three categories according to their intermediation role: merchant wholesalers, manufacturers' sales offices, and agents (Exhibit 5). Merchant wholesalers purchase, store, and sell goods. They account for 60 percent of sales and 80 percent of employment. Sales branches of manufacturers market and coordinate distribution directly to the buyer. They account for 30 percent of sales and 15 percent of employment. Finally, agents coordinate the sale of goods but never take title to the goods and typically earn a commission for doing so. They account for 10 percent of sales and 5 percent of employment.

Only approximately one-third of wholesale sales go to retailers. The remainder consists of sales from one wholesaler to another, or sales from wholesalers to manufacturers (Exhibit 5).

Employment in this sector is broken down in Exhibit 6. Around 50 percent of employees take on administrative or marketing and sales functions, and almost 20 percent consist of operators.

Wholesale trade is quite a capital-intensive sector, with $11,609 of nominal IT capital per worker (PEP) in 1996 versus an economy-wide average of $6,177. However, a large proportion of this IT equipment is actually leased out and its usage is therefore not counted as part of wholesale, so its high IT intensity compared to other sectors is somewhat misleading.

Importance of the wholesale trade industry to the overall question

Wholesale trade (as defined by Census and BEA) contributed 0.37 percent to the overall US[1] productivity jump of 1.33 percent between the periods of 1987-95 and 1995-99, as measured by the BEA. This is the largest contribution of any sector in the economy. (Exhibit 1).

- ¶ The main contribution of wholesale trade to the aggregate US productivity growth jump (based on BEA data) came from within-sector productivity growth, as opposed to a mix shift in the economy.

- ¶ Over the time period examined by MGI, wholesale trade increased its labor productivity growth rates by over 5 percent (from 2.9 percent to 8.2 percent per year, 1987-95 *versus* 1995-99).

Wholesale trade exhibited a 4 percent jump in the growth rate of real IT capital intensity (from 12.7 percent to 16.9 percent per year, 1987-95 *versus*1995-99). (Exhibit 2). This behavior was consistent with the US economy over this time period.

Data sources

Each of the subsectors of wholesale consists of different products and different micro-economic markets (often referred to as “verticals") with little if any linkages. Therefore, any study of productivity performance and its driving factors must be done at the subsector level.

The Bureau of the Census, the BEA, and the BLS (United States Government Bureau of Labor Statistics) all collect data on wholesale trade. However, these three agencies do not collect a full set of data yearly (Exhibit 7). Hence, any aggregate or subsector productivity calculations using solely government data

1 Nonfarm private

would require interpolation and extrapolation. In our opinion, these assumptions would be too crude for a sensitive calculation of a differential of productivity growth.

¶ The Bureau of the Census does not collect yearly total sales data for this $4 trillion industry. Total sales data are collected only during Census years (every 5 years). Yearly sales data are collected only for merchant wholesalers who make up 60 percent of total wholesale sales.

¶ The BEA does not calculate value-added data by subsector (three-digit SIC code) for wholesale, thereby making it impossible to locate the source of the dramatic jump in wholesale productivity growth as measured by the BEA. The only subsector data available for wholesale from the BEA is gross output. Gross output for wholesale is calculated as gross margin (as opposed to sales for most other industries). These gross margin data are estimated by the BEA and, due to the above-mentioned lack of source data, the BEA relies on substantial assumptions and estimates to derive yearly data.

¶ The BLS does capture yearly employment data for all of wholesale by subsector. However, these data are not broken out by type of wholesaler (i.e., merchant wholesaler *versus* agent *versus* sales offices).   There are therefore no yearly employment data comparable to the yearly sales data collected by the Census.

Scope of study

MGI's industry definition of wholesale trade is identical to that of the US Census and BEA (SIC codes 50 and 51).

To allow a meaningful and specific-enough understanding of the causes of a productivity growth jump, we studied a subsector with adequate data availability from alternative sources, i.e., pharmaceutical wholesale. This wholesale subsector represents 5 percent of 1997 nominal wholesale sales

PHARMACEUTICALS

To understand the causes of the acceleration of labor productivity growth and the role of IT, this section focuses on pharmaceutical wholesaling. We chose to study this subsector for two reasons. Firstly, data were available from the NWDA; secondly, pharmaceutical wholesaling is one of the most technologically progressive wholesale segments. If we believe that the other segments will soon follow, then the study of this subsector should provide some insight into the future of the whole sector, including the upper limit of IT impact on the wholesale industry.

Subsector profile

According to the 1997 Census, this sector accounts for 5 percent of total wholesale sales. Real merchant wholesale sales (the only yearly sales data available from statistical agencies sources) jumped from a 7.2 percent growth rate to an 11.6 percent growth rate from 1987-95 to 1995-99. The BLS data show that pharmaceutical wholesale comprises 3 percent of total hours worked, which jumped from 2.1 percent to 3.5 percent.

Industry data show that there are more than 40 full-line pharmaceutical wholesalers in the US. However, four companies control 95 percent of the market. This intense level of concentration is due to major consolidation activity for the past 20 years. These four companies are listed in order of diminishing size. McKesson (which was the first national wholesaler), Bergen Brunswig (which became national in 1992), Cardinal Health (recently acquired Bindley Western and became national in 1994) and AmeriSource (which reached national status in 1996).

Data sources and scope

Our primary source of labor productivity data is the NWDA, founded in 1886, which is the primary association for pharmaceutical wholesaling. This association collects and publishes data on their membership, which comprises approximately 80 percent of the companies in the industry including the top four.

The Census also collects information on this subsector (SIC 5122 or NAICS 4222, titled "Non-durable wholesale-distributors of Pharmaceuticals, Proprietaries and Sundries"). The Census sector definition is wider in scope than that of the NWDA as it includes many companies whose primary line of business is not drug wholesaling, such as generic drug manufacturers and retail pharmacies (Exhibit 8).

Link with aggregate productivity growth jump

Due to a lack of data, we are unable to link the productivity jump we find in pharmaceuticals to its share of the total wholesale value-added productivity jump. This is due to the fact, as mentioned earlier, that there is no BEA estimate of value added by subsector. Our estimate of productivity for pharmaceutical wholesaling is, therefore, based on sales as opposed to value added, making it difficult to compare this estimate with the total value-added productivity data.

However, if we are willing to use value added and sales productivity estimates interchangeably, we can infer the contribution of pharmaceuticals to the value-added jump. We do this by using sales data to weight the sales-based productivity growth in the pharmaceutical sector and then calculate its contribution to total productivity growth. Doing so results in a pharmaceutical sector contribution of

0.03 percent out of the 0.37 percent total wholesale contribution to the aggregate jump.

Labor productivity performance

Our estimate of labor productivity for pharmaceutical wholesaling is based on sales per labor input as opposed to value added. This is due to lack of data from which to calculate value added.

The NWDA publishes median sales per distribution center employee over time. The distribution center corresponds primarily to the traditional wholesaling activities, which include selling, purchasing, and administration. Deflating these numbers by a sales deflator that we calculated from BLS price indexes yields a productivity increase (based on throughput per employee) from 2.77 percent to 7.35 percent, resulting in a delta productivity growth of 4.58 percent (Exhibit 9; see appendix for specific methodology). We must, however, acknowledge the fact that the median may not match the mean if the distribution is skewed. The dominance of the top four players, who are significantly more productive than the great majority of their smaller competitors, leads us to believe that the distribution is skewed and that this NWDA estimate is a lower bound for productivity growth.

We made alternative productivity estimates based on the key trends in the subsector: a shift to selling higher-value pharmaceuticals, warehouse automation, improvements in organization of functions and tasks (OFT), and an increase in the scale of operation. These trends are detailed in the section hereunder on the sources of the productivity growth acceleration. Our labor productivity estimates show a jump from 3.6 percent 1987-95 to 11.0 percent 1995-99 resulting in a delta productivity growth of 7.4 percent (Exhibit 9). These estimates are close to the NWDA estimates but a bit higher as we expected.

Explaining the jump in 1995-99 labor productivity growth

Exhibit 10 summarizes our causality analysis in pharmaceutical wholesaling. This section will elaborate on the various factors listed in the exhibit.

Firm-level ("operational") factors

At the firm level, the real sales per employee jump was primarily driven by the increase in service embedded in the passing-through of higher-value drugs, accelerating improvements in warehouse automation, and OFT. Scale effects resulting from serving larger retailers contributed to productivity growth in both periods, but not to the acceleration of productivity growth (Exhibit 11).

Shift to higher-value drugs in the basket of drugs intermediated by wholesalers. Real sales growth can occur due to an increase in either the number of units or the average real revenue per unit. The growth rate of real revenue per prescription drug[2] (average price per unit deflated by the appropriate price index; see appendix for calculation detail) jumped from 6.35 percent to 9.04 percent between 1987-95 and 1995-99 (Exhibit 12). This occurred when manufacturers introduced more goods of higher value, i.e., more new blockbuster pharmaceuticals.

For this effect to translate into productivity growth, two things must hold: first, the passing-through of higher-value drugs by a wholesaler must be viewed as an increase in service; second, the quantity of labor input required to provide these higher-value drugs must not be different. For the first point to hold, the ultimate customer must derive more value out of a higher-value good made available by the wholesaler. With regard to the second point, although the quantity of labor required to handle different drugs may vary (i.e., due to refrigeration requirements or security issues), there does not appear to be a direct relation between the value of the drug and the amount of labor required.

Automation and OFT. Pharmaceutical distribution centers must keep a constant inventory of tens of thousands of different drugs/SKUs in stock. Stocking, picking, and shipping such an enormous variety of products is very complicated, labor intensive, and vulnerable to human error. Any improvements to these processes can therefore yield major productivity improvements. In fact, employment consists of 70 percent direct labor and 30 percent indirect labor (Exhibit 13), with over half the direct labor consisting of people picking and loading goods.

¶ **Automation.** We use the term "warehouse automation" as a broad characterization of both the hardware (i.e., barcodes, scanners, automated picking machines, conveyers) and software (warehouse management systems that control inventory and its movement through the warehouse) implemented to automate the flow of goods and control of inventory in the warehouse (see Exhibit 14 for benefits of warehouse management systems). Increased automation of basic tasks in warehouses can allow for a dramatic increase in distribution center labor productivity. Common modifications include automating the picking process and streamlining order flow using computer controls, automated picking equipment (i.e., lightweight wearable computers), and conveyer systems. Exhibit 15 gives some tangible examples of specific

2 Prescription pharmaceuticals, according to the NWDA, account for 88 percent of pharmaceutical wholesaler sales

improvement possible due to IT implementation.

The labor productivity improvement realized from these upgrades is primarily due to more efficient picking, packing, and shipping, which affects approximately 60 percent of direct distribution center labor. In the latter part of the 1990s, pharmaceutical wholesalers were upgrading and expanding the size of their warehouse facilities substantially, a trend that went hand in hand with sector and distribution center consolidation.

¶ **OFT.** Equally important as warehouse automation is "nuts and bolts" improvements of the OFT. Many of these changes are relatively costless but can yield impressive impact on labor productivity. Exhibit 16 provides various examples of these types of changes.

- A clear illustration would be reducing the distance between high turnover pallets and entry-exit doors, thereby minimizing the time it takes to fetch products that are constantly in demand.
- Another example would be changing the method of order picking. Traditional order picking meant that each picker completed one order at a time, often having to travel the entire warehouse to complete an order. We have seen increasing adoption of new picking techniques, such as batch picking, at which each order picker picks items for several orders simultaneously and sorts during the picking process (thereby reducing intrawarehouse travel time per item) and zone picking, where each order picker is assigned to a zone of the warehouse regardless of the customer order.

Scale effects from serving larger retailers. For the 55 percent of pharmaceutical wholesale sales that go to retail, there has been a continuing trend in market share shift toward chains and mass retailers selling pharmaceuticals and away from independents. There are clear benefits to wholesale labor productivity of serving such larger customers. Larger retailers require much larger shipments, thereby reducing the number of different deliveries the wholesaler must make to achieve a certain sales level. Chains also require far fewer labor-intensive, value-added services, which shows up as lower productivity using a throughput measure. However, this shift toward chains and mass retailers has slowed in the latter part of the 1990s and therefore does not contribute to explaining the productivity growth jump.

Industry dynamics

Until the early 1990s, the wholesale pharmaceutical industry was a very profitable business. Margins were high at around 8 percent and there was major overcapacity in the system. Wholesale margins have been squeezed over the past 10 years, forcing wholesalers to become much more cost conscious (Exhibit 17).

This in large part drove the quick spread of warehouse automation in the later part of the 1990's. Since larger wholesalers more easily undertake warehouse automation, significant industry consolidation occurred. Larger wholesalers find it easier to implement warehouse automation for two reasons: high capital requirements and minimum efficient scale. Consolidation was also encouraged by the fact that large national retailers expected to be served by national wholesalers (McKesson was the only national wholesaler until 1992).

Dramatic consolidation of distribution centers has resulted from the frenzied pace of acquisitions by a small number of very large wholesalers. Exhibit 18 shows that the five largest companies have increased their market share from 65 percent to 95 percent between 1987 and 1999. This acquisition trend is corroborated by press releases showing a dramatic reduction in distribution centers (Exhibit 19). For example, the outcome of the McKesson and Foxmeyer merger was to reduce their total number of distribution centers from 57 to 39.

Consolidation accelerated the diffusion of warehouse automation both directly and indirectly.

¶ The direct impact came from two sources: first, large wholesalers have modern warehouses with very high capacity and can therefore dramatically increase productivity by "buying demand" through an acquisition; second, large wholesalers modernize warehouses they acquire.

¶ Indirect growth comes via the extra price pressure on less efficient competitors. All this consolidation results in larger companies replacing small local distribution centers with large regional warehouses and renovating older warehouses.

The FTC analysis of the Cardinal Health/Bergen Brunswig as well as the McKesson/AmeriSource merger proposals in 1997 includes projections of savings due to consolidation of $80 million to $90 million for each. Ongoing consolidation was the primary means by which best practices diffused throughout the industry, thereby dramatically increasing productivity levels.

External Factors

Productivity gains at the firm level were triggered by the consolidation of customers, i.e., retail, and by the accelerated introduction of higher-value drugs by manufacturers.

Larger and more powerful customers put major price pressure on wholesalers and encouraged consolidation. Consolidation in retail (55 percent of wholesale sales), which reached a critical mass, and the formation of institutional group purchasing organizations (GPOs – 45 percent of wholesale sales) have both contributed to a dramatic reduction in wholesale margins (Exhibit 20).

¶ Large retailers have the buying power and infrastructure (their own warehouse system) to buy directly from the manufacturer and circumvent the wholesaler. In fact, currently, retailers self-warehouse approximately 65 percent of the pharmaceuticals they purchase. This practice has created a competitor for distributors, forcing the wholesaler to streamline their existing distribution operations (and often consolidate) to be able to compete.

¶ Larger retailers prefer to deal with large wholesalers who carry all the products they need. This encouraged consolidation in wholesale, resulting in the top five companies gaining significant market share. The motivation for this consolidation is twofold:

- To achieve greater product variety to fully cover the needs of the retailer.
- To achieve full geographic coverage of the US market. This is best illustrated by the fact that in 1992, McKesson was the only national wholesaler; but by 1997, the top four all reached national status.
- Although GPOs do not generally self-warehouse, they do have the buying power to circumvent the wholesaler and purchase directly from manufacturers, thereby increasing pressure on wholesalers.

Wholesalers were, therefore, squeezed on both ends by a consolidating downstream industry as well as already powerful manufacturers. This increased pressure on wholesalers is clearly demonstrated by the halving in gross margin in the past 10 years from 8 percent to 4 percent.

The increase in the average real revenue, or value, of pharmaceuticals has primarily been driven by the accelerated flow of new advanced drugs to the market. Massive R&D investments from the past two decades are paying off and the FDA is approving new pharmaceuticals more quickly than in the past. Those new pharmaceuticals bring superior value to the customer and typically command higher prices, as no alternative treatment of equal quality and effectiveness exists. For example, the Drug Trend Report shows that prescription drug costs rose by two-thirds from 1994 to 1998 and that new pharmaceuticals introduced since 1994 represented almost half of this growth.

Sustainability

We estimate that the entire 11.0 percentage point productivity growth in pharmaceutical wholesaling from 1995 to 1999 is likely to be sustainable over the next 5 years.

We assume that the improvements in OFT are sustainable because recent consolidation created opportunities for further rationalization and diffusion of best practice.

In terms of warehouse automation, because penetration has still only reached an estimated 50 percent, there is plenty of room to improve industry-wide productivity through warehouse improvements. Therefore, as long as competitive intensity is maintained to provide the incentive to continue operational improvements, we believe that there are still great gains to be made.

Price increases in prescription pharmaceuticals are widely expected to continue due to the factors noted above, namely the accelerated flow of new advanced drugs to the market (Exhibit 21).

Finally, efficiency gains from serving larger retail customers should be sustainable since there is room for further consolidation in retail as independent pharmacies still retained a 23 percent share of the market in 1999.

OVERVIEW OF THE REST OF WHOLESALE

Because MGI did not study any other wholesale sector with the same level of rigor it applied to pharmaceuticals, it is not possible to specify with precision what caused the productivity growth jump beyond pharmaceuticals. The same argument applies for determining the sustainability of productivity growth in the remainder of wholesale. However, the extrapolation of various factors we found to be important in pharmaceutical wholesale allowed us to narrow the range of both in terms of the impact of these factors on past productivity growth as well as on their future sustainability.

Causality in the rest of wholesale

As discussed earlier, our analysis of pharmaceutical wholesale allows us to understand 0.03 percent of the 0.37 percent jump. When looking at the rest of wholesale and sustainability, we work in the context of the 1995-99 growth rate contribution. For wholesale this is 0.57 percent and for wholesale excluding pharmaceuticals it is 0.52 percent. We have found that of the 0.52 percent contribution in the rest of wholesale, at least[3] 0.08 percent is due to the substitution to higher-value goods and 0.07 percent is due to the automation of warehouses.

3 In product categories where we had data to carry out analysis, .ie., apparel, lumber, and groceries. This effect could have happened in other product categories.

In the study of productivity acceleration in the retail sector, we have identified a number of product categories where a substitution to higher-value goods took place. Because a significant portion (approximately 40 percent) of wholesale sales is directed to the retail sector (either directly or indirectly for example through another wholesaler), we know that this portion (at least) experienced such a substitution. This substitution to higher-value goods leads to higher productivity since the wholesaler provides a higher service to its customers by delivering higher-value goods (see the retail case for an more in-depth discussion).

Our methodology for estimating the impact of the switch to higher-value goods in the rest of wholesale was as follows. We used the acceleration in the growth rate of real revenue per unit calculated in retail for the relevant subsectors[4] and weighed these by the share of the wholesale sales directed at the relevant retail subsectors.

We have also made an assessment of the extent to which significant warehouse automation took place. New warehouse automation in other wholesale subsectors is estimated to contribute 0.07 percent based on estimated benefits and penetration rates.

¶ This automation consists of two major components: physical automation and warehouse management systems (WMS). Data on the market size and adoption rate of WMS are readily available, thereby allowing us to make some estimates of the potential for this factor to have a major impact in other sectors of wholesale.

¶ The adoption rate of WMS is higher than that of physical automation; therefore, focusing on this part of the segment provides an upper bound for warehouse automation. Exhibit 22 shows the total size of the WMS market. The rate of increase of the size of the market has accelerated dramatically post 1995. Wholesale accounts for a fairly sizeable 15 percent of this market. Exhibit 23 shows the adoption rates of WMS by manufacturing subsectors. Industry experts view this data as a fair proxy for wholesale penetration rates.

Sustainability in the rest of wholesale

Of the 0.57 percent contribution, 0.52 percent comes from unstudied sub sectors of wholesale trade. We were able to shed some light on the sources of this jump by measuring the impact of effects we found in pharmaceutical wholesaling (substitution to higher-value goods, warehouse automation) across the whole

4 Retail subsectors where substitution to higher-value goods have been identified and measured

sector. We now discuss whether or not these effects are sustainable in the rest of wholesale.

Out of 0.52 percent, between 0.08 percent[5] and 0.52 percent is sustainable. The lower bound of this range results from productivity improvements due to the penetration of warehouse automation in wholesale trade. Included in this range is the substitution to higher-value goods of 0.08 percent; however, we cannot identify how much of this is sustainable. We estimated that the current penetration rate of warehouse automation systems in wholesaling leaves plenty of room for major productivity improvements in the future.

We must keep in mind that different sectors have different potential for adoption of these systems due to product range, physical characteristics of the goods and so forth. For example, with very costly, small and easy-to-handle products, pharmaceuticals are highly suitable for these systems. On the other hand, the motor vehicles subsector may reap less impact from these systems.

The penetration rates are still quite low. Our estimate of the penetration rates in pharmaceuticals in 1999 was 50 percent; across these manufacturing industries, the rates are mostly around 20 percent.

* * *

In conclusion, productivity growth in 1995-99 in wholesale contributes 0.57 percent of the total economy-wide productivity growth in this period. Through our analysis of pharmaceutical wholesale we analyze 0.05 percent of this jump and find it to be completely sustainable. We extend our analysis of warehouse automation to other subsectors of wholesale by using penetration rate data. This analysis yields 0.08 percent of the jump to be sustainable. We are therefore able to narrow the range of sustainability of the growth from a substantial 0.00 percent to 0.57 percent, to a more modest 0.13 percent to 0.57 percent. This range in turn contributes to our overall estimate of sustainability for the economy.

5 This is higher than the 0.07 percent mentioned in the previous section due to our estimation of the increase in penetration rates of these systems for the coming 5 years. This estimate is based both on the dramatic increase in penetration that we have observed in the pharmaceutical wholesale subsector as well as expected penetration rates reported by manufacturers.

APPENDIX

Calculation of sales deflator

Our calculation of a sales deflator for pharmaceutical wholesale was based on a combination of CPIs available from the BLS. We chose these deflators and weighted them according to the product breakdown of sales provided by the NWDA. This allowed us to create a CPI for the appropriate product mix. We then adjusted the CPI (which is created at the retail level) for retail margins to come up with a deflator for wholesale sales output. The components of this calculation are shown in Exhibit 24.

CONFIDENTIAL

Wholesale

Wholesale write-up

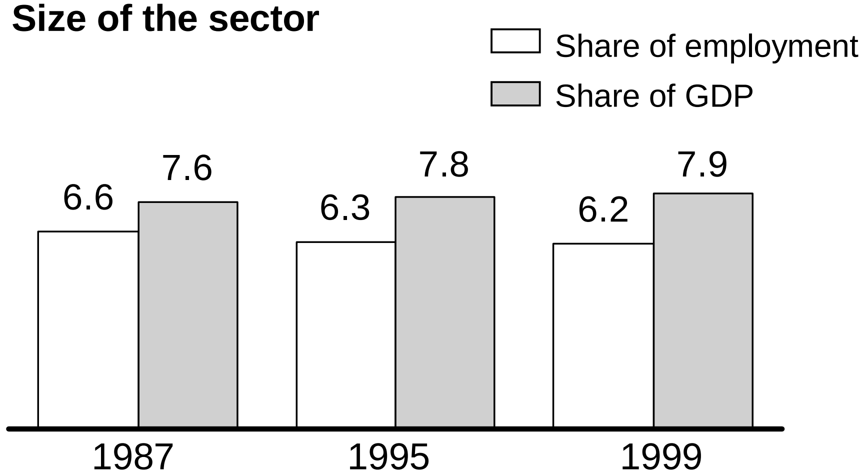
September 5, 2001

Exhibit 1

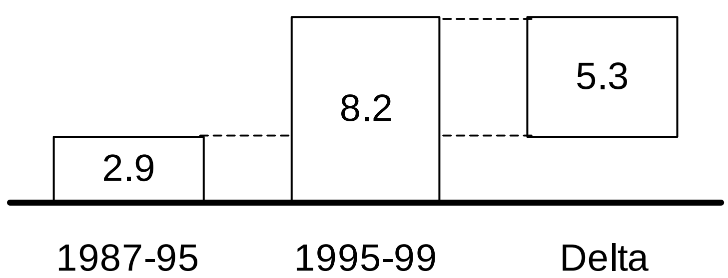
WHOLESALE IS THE LARGEST CONTRIBUTOR TO THE ACCELERATION IN OVERALL US PRODUCTIVITY GROWTH

Percent

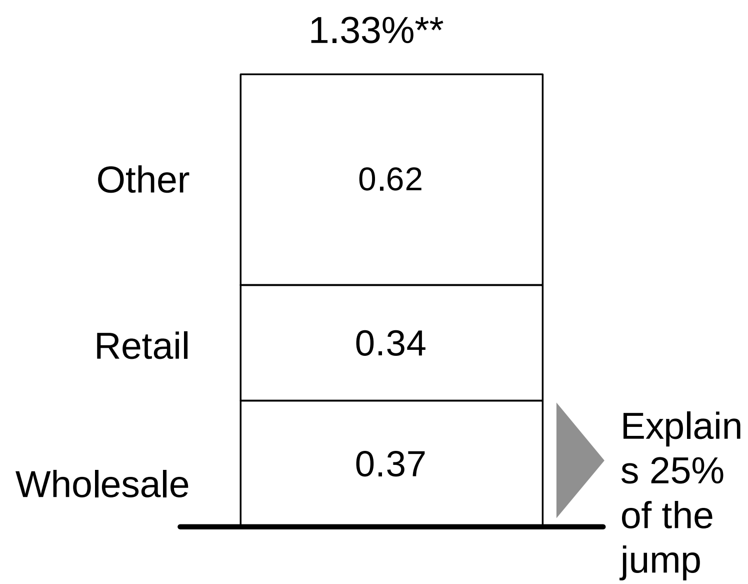
Size of the sector



Wholesale value-added productivity growth*



Delta productivity growth rate
1995-99 vs 1987-95

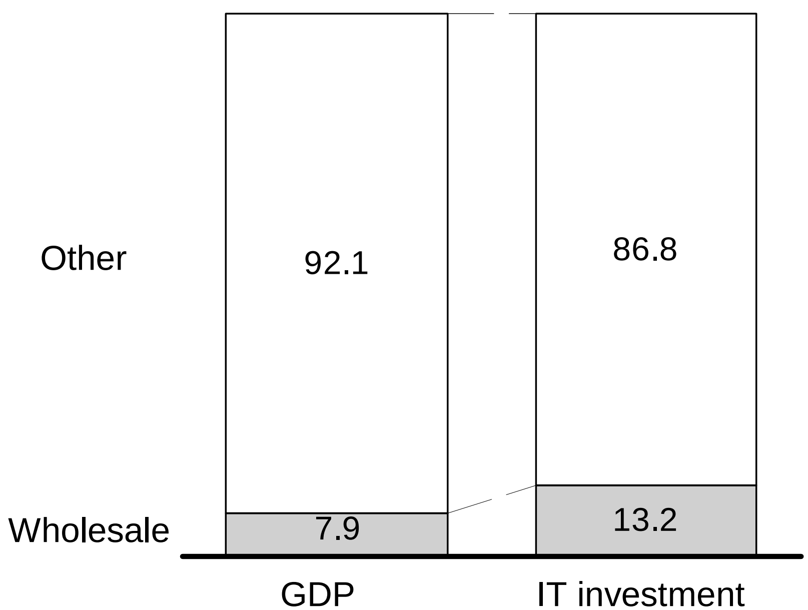


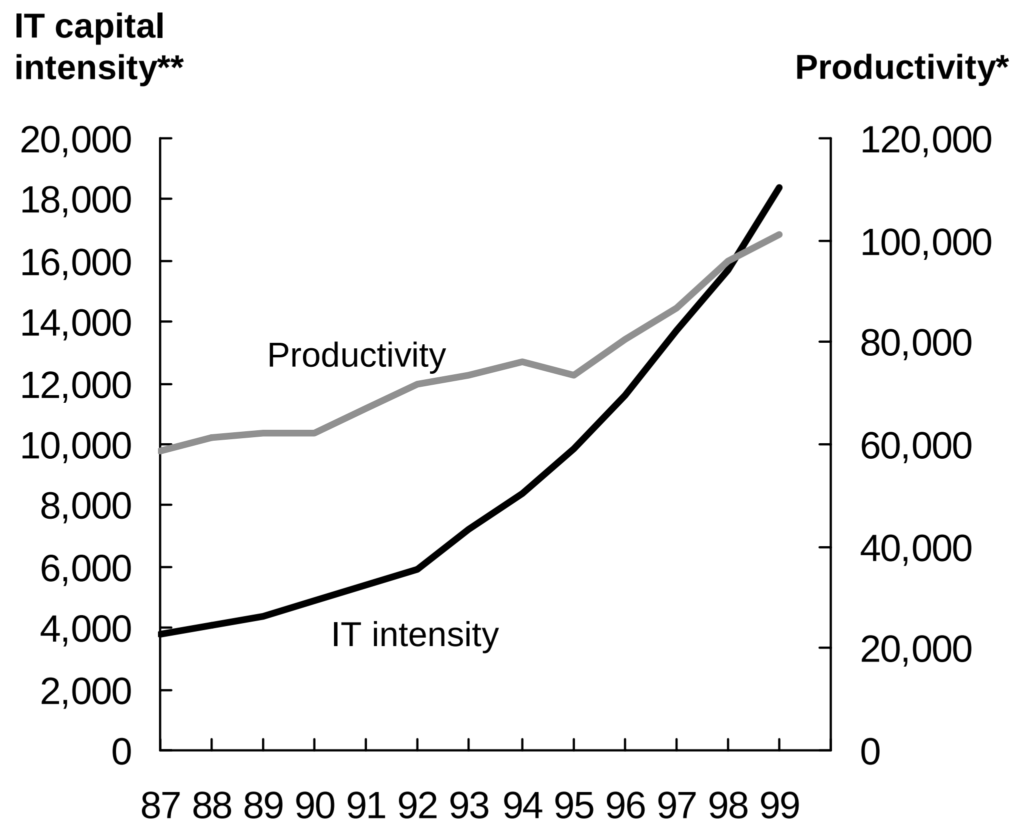
* GPO over PEP
** Non-farm private
Source: BEA; McKinsey

Exhibit 2

WHOLESALE'S IT SPENDING HIGH COMPARED TO SHARE OF GDP, WITH INTENSITY ACCELERATING AFTER 1995

1999 share of GDP and IT investment
Percent





CAGR (percent)	**1987-95**	**1995-99**
Productivity	2.9	8.2
IT capital intensity	12.7	16.9
Aggregate IT capital intensity	6.0	13.9

* Real GPO over PEP
** Real IT capital over PEP
Source: BEA; McKinsey analysis

Exhibit 3

WHOLESALER ROLE IS EVOLVING

Focus of wholesale study

Role	Captured in SIC 5122 by BEA	Examples
Traditional distributor	Yes	Wholesaler purchases from manufacturer, stores goods in own warehouse, and delivers them to the retailer
Brokerage	Yes	Retailer bypasses wholesaler's warehouse but uses their billing function
New activities	Unlikely; probably captured in manufacturing and business services SICs	Cardinal Health pharmaceutical technologies and services division activities – Manufacturer drug-delivery technologies – Provide packaging services – Produce sterile liquid pharmaceuticals – Provide sales & marketing services for pharmaceutical companies

Source: McKinsey

Exhibit 4

WHOLESALE IS FRAGMENTED

Percent, 1997

Source: 1997 Census of Wholesale Trade

Exhibit 5

CENSUS DISAGGREGATES WHOLESALE SALES BY TYPE OF INTERMEDIATION

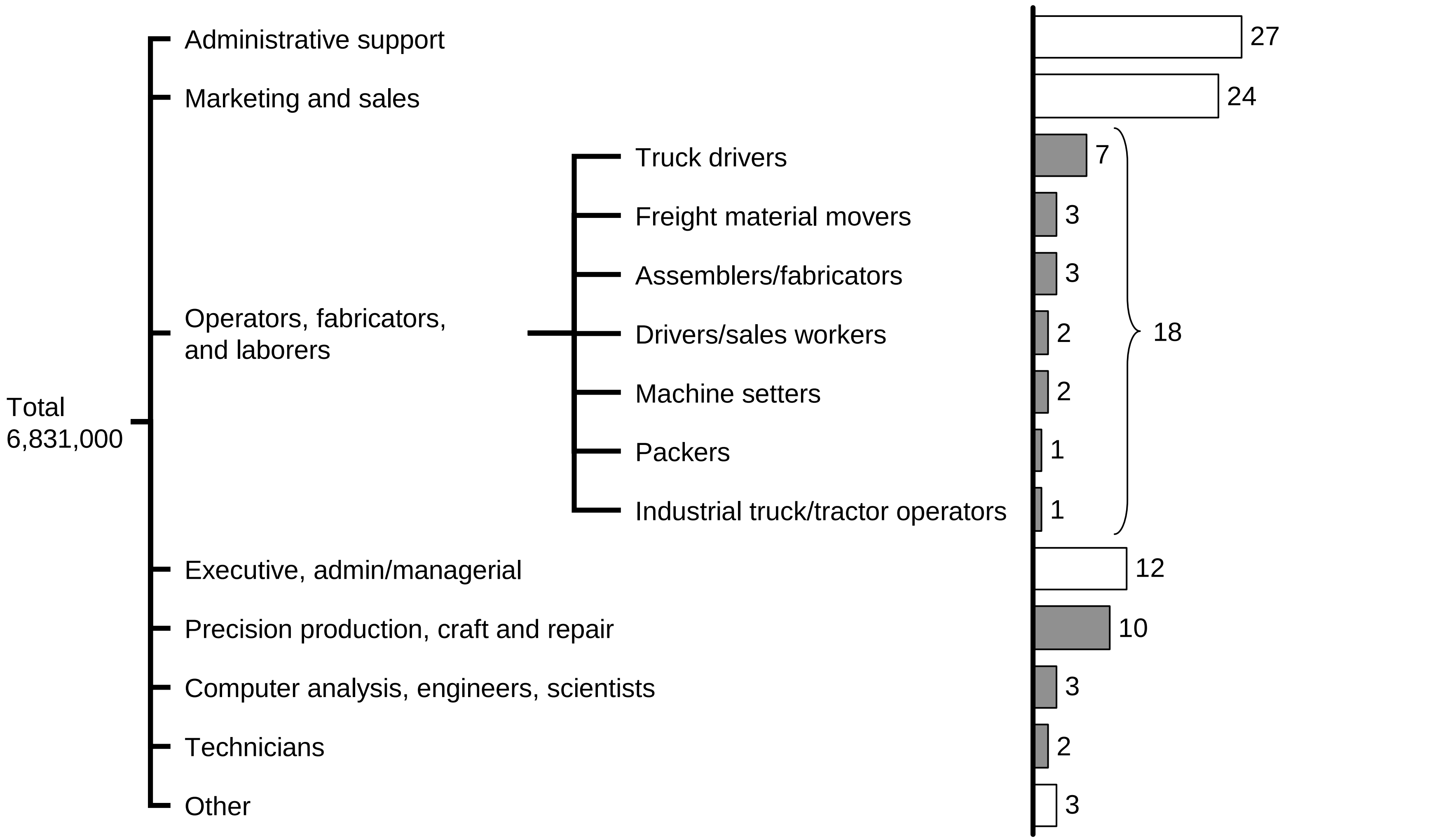
$ Trillion, 1997

Source: 1997 Census of Wholesale Trade; McKinsey analysis

Exhibit 6

DISTRIBUTION CENTER FUNCTIONS ACCOUNT FOR ~40% OF WHOLESALE EMPLOYMENT

Percent



Note: Breakdown from census by subsector shows very little difference between pharmaceutical wholesalers and merchants in general

Source: U.S. Department of Labor

Exhibit 7

THE WHOLESALE INDUSTRY LACKS CRITICAL OUTPUT DATA

Available in retail

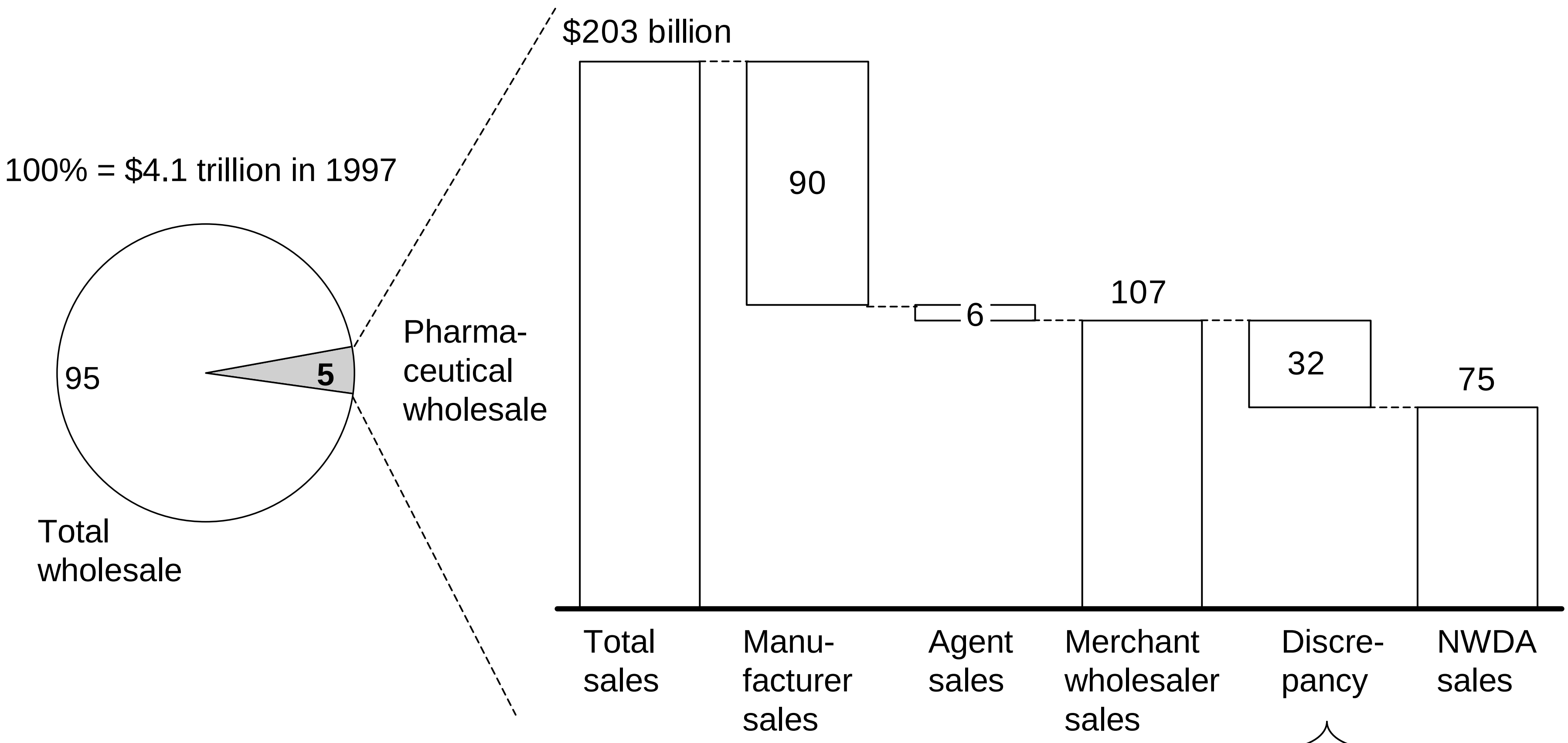
	Subsector*		Total	
	1 year	5 year	1 year	5 year
BEA				
Value added	✗	✗	✓	✓
Gross margin	✓	✓	✓	✓
Purchased services	✗	✗	✓	✓
Census				
Sales	✗	✓	✗	✓
Purchased services	✗	✗	✗	✗

* Level of data required for microeconomic analysis

Source: BEA; Census; McKinsey

Exhibit 8

SCOPE OF PHARMACEUTICAL WHOLESALE CASE



- NWDA collects data from their members only
- Census includes companies whose primary line of business is not pharmaceutical wholesale

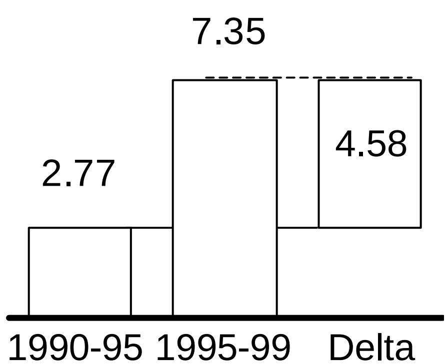
Source: Census; National Wholesale Druggists' Association (NWDA)

Exhibit 9

DISTRIBUTION CENTER PRODUCTIVITY

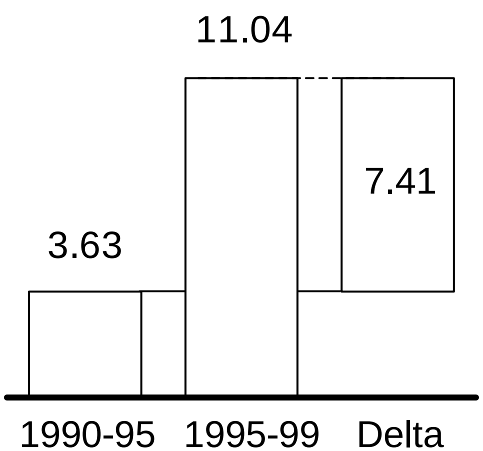
CAGR, percent

Median real sales per distribution center employee



- Median is an underestimate since we believe the distribution is skewed
- We have made an estimate of average productivity based on a bottom-up approach

Estimate of average real sales per distribution center employee



Source: NWDA; McKinsey analysis

Exhibit 10

CASUALTY ANALYSIS EXPLAINS PRODUCTIVITY JUMP IN WHOLESALE

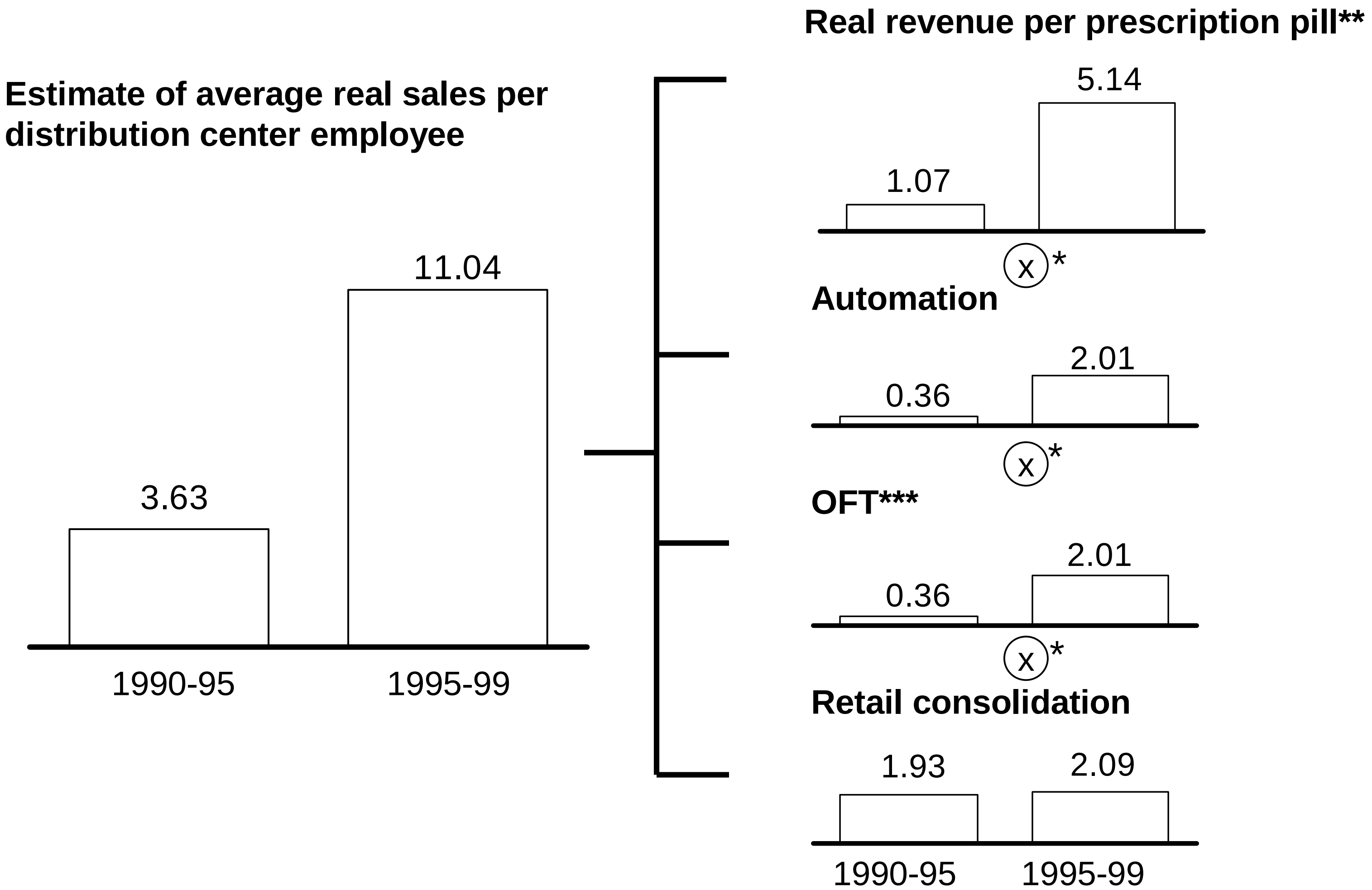
● Important (>50% of acceleration)
◑ Somewhat important (10-50% of acceleration)
○ Not important (<10% of acceleration; asterisk to right indicates significant negative)

External factors	• Demand factors (macro-economic/financial markets)	X	
	• Technology/innovation	●	Innovation in drug manufacturing industry increases drug prices
	• Product market regulation	X	
	• Up-/downstream industries	◑	Retail consolidation puts cost pressure on wholesalers
	• Measurement issues	X	
Industry dynamics	• Competitive intensity	●	Consolidation
	• Price/demand effects	X	
Firm-level factors	• Output mix	X	
	• Capital/technology/capacity	◑	Warehouse automation systems
	• Intermediate inputs/techn.	●	Passing through of higher value drugs
	• Labor skills	X	
	• Labor economies of scale	X	
	• OFT/process design	◑	Optimizing workforce and warehouse layout

Exhibit 11

OVERALL EFFECT OF DIFFERENT FACTORS ON PRODUCTIVITY

CAGR, percent



* Calculation is (1 + growth rate 1) * (1 + growth rate 2)

** Prescription drugs account for only 88% of wholesale sales, assume average price of other products follow CPI

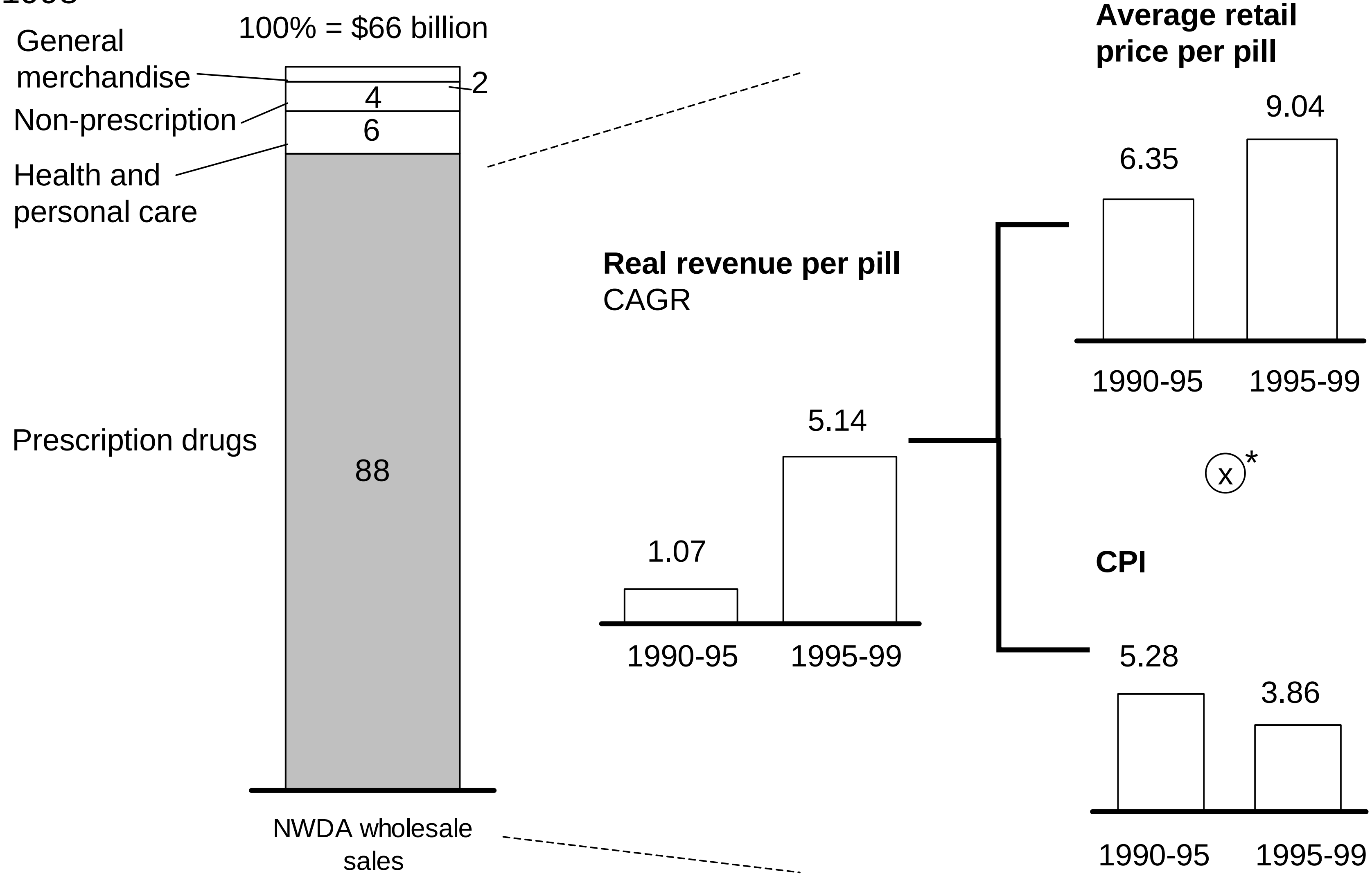
*** Identified as same size effect by industry expert

Source: Interviews; NWDA; Modern Materials Handling magazine article; McKinsey analysis

Exhibit 12

SALE OF HIGHER-VALUE PRESCRIPTION DRUGS LED TO PRODUCTIVITY JUMP

1998



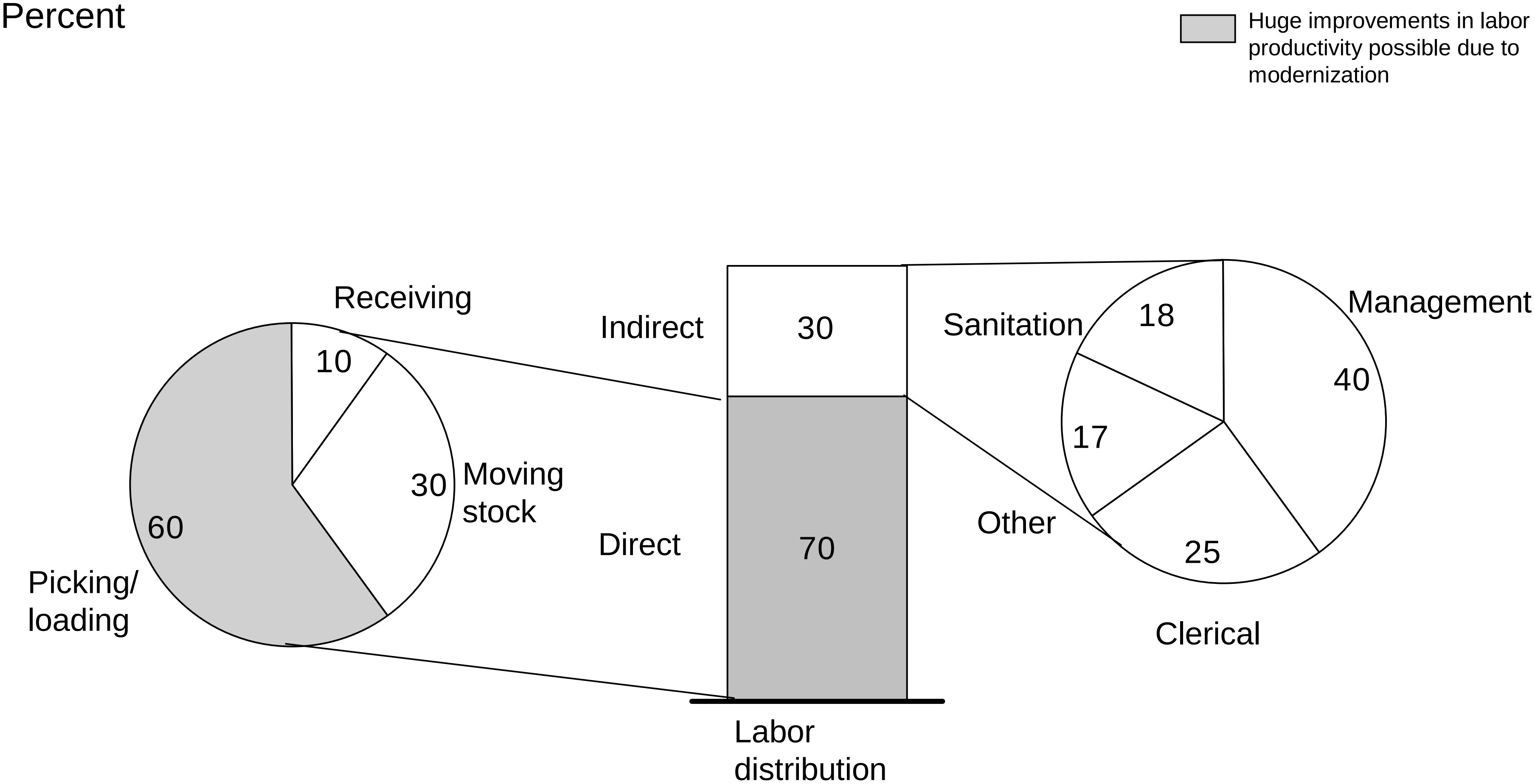
* Calculation is (1 + growth rate 1) * (1 + growth rate 2)

Source: NWDA; IMS; BLS; McKinsey analysis

Exhibit 13

PICKING/LOADING THE LARGEST TASK IN A DISTRIBUTION CENTERS

Percent



* Indirect labor includes director of distribution center and below

Source: NWDA; McKinsey analysis; Interviews

Exhibit 14

WAREHOUSE MANAGEMENT SYSTEMS (WMS) HAVE BENEFITS

Enable

- JIT programs
- Real-time access to inventory
- Utilization of automated material handling equipment
- Supply chain visibility
- Large-scale value-added services and light manufacturing operations

Reduce

- Damage
- Inventory levels
- Labor (i.e., product handling) and equipment costs
- Paperwork and human error
- Physical inventory counts

Improve

- High-volume throughput
- Order, lot, and serial number tracking
- Storage utilization
- Pick sequences
- Inventory accuracy and integrity
- Back-order tracking and cross-docking
- Labor and equipment productivity
- Resource planning and scheduling

Source: AMR Research Report on Supply Chain Management

Exhibit 15

WAREHOUSE PRODUCTIVITY IMPROVEMENTS ENABLED BY AUTOMATION/MODERNIZATION

Actions	IT employed
Implement conveyer system	• Scanning system to move goods through conveyer belts
Track products in real time	• Hand-held scanners connected by radio • Bar codes
Reduce control after picking	• Scanners
Interface operational processes	• Computer interface

Improvements

- Better productivity (decrease in labor required)
- Locate products in real time and do JIT replenishment of the picking area
- Less location errors due to improved stock accuracy
- Elimination of manual data entry
- Ability to react quickly to changes

Source: McKinsey

Exhibit 16

WAREHOUSE PRODUCTIVITY IMPROVEMENT ENABLED BY OFT

Actions

- Optimize warehouse opening/closing hours for entry/exit activities
- Reduce distance between high turnover pallets and entry/exit doors
- Organize picking layout to minimize time-consuming movements
- Ensure picking orders are ready at the start of the shift
- Use names to replace SKUs for picking products
- Implement incentive systems for workers
- Improve picking techniques

→

Improvements

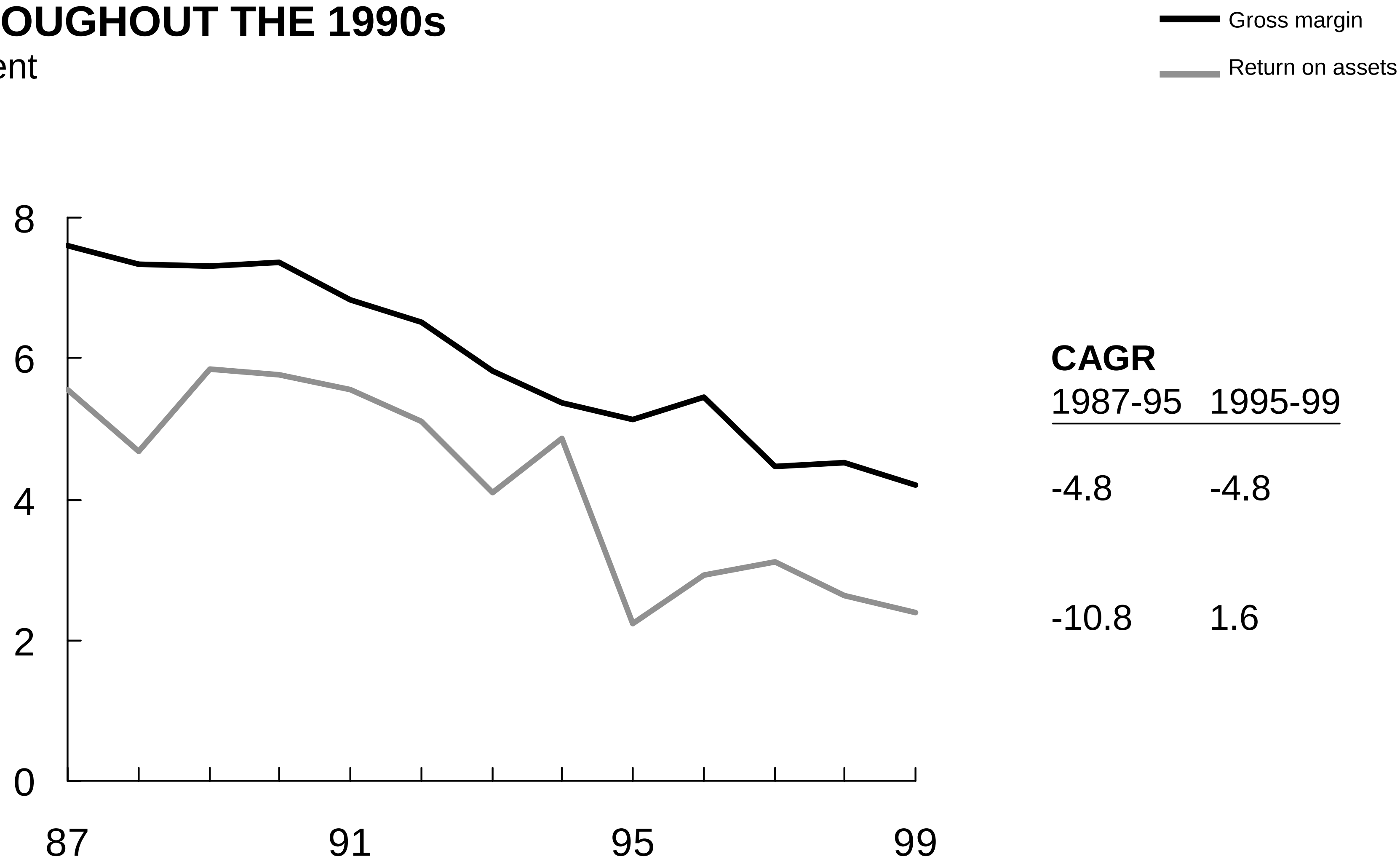
- Better productivity
- More accuracy
- Align staff to actual product inflows and outflows
- Decrease dock and door saturation

Source: McKinsey

Exhibit 17

WHOLESALE MARGINS AND RETURNS DETERIORATED THROUGHOUT THE 1990s

Percent



CAGR

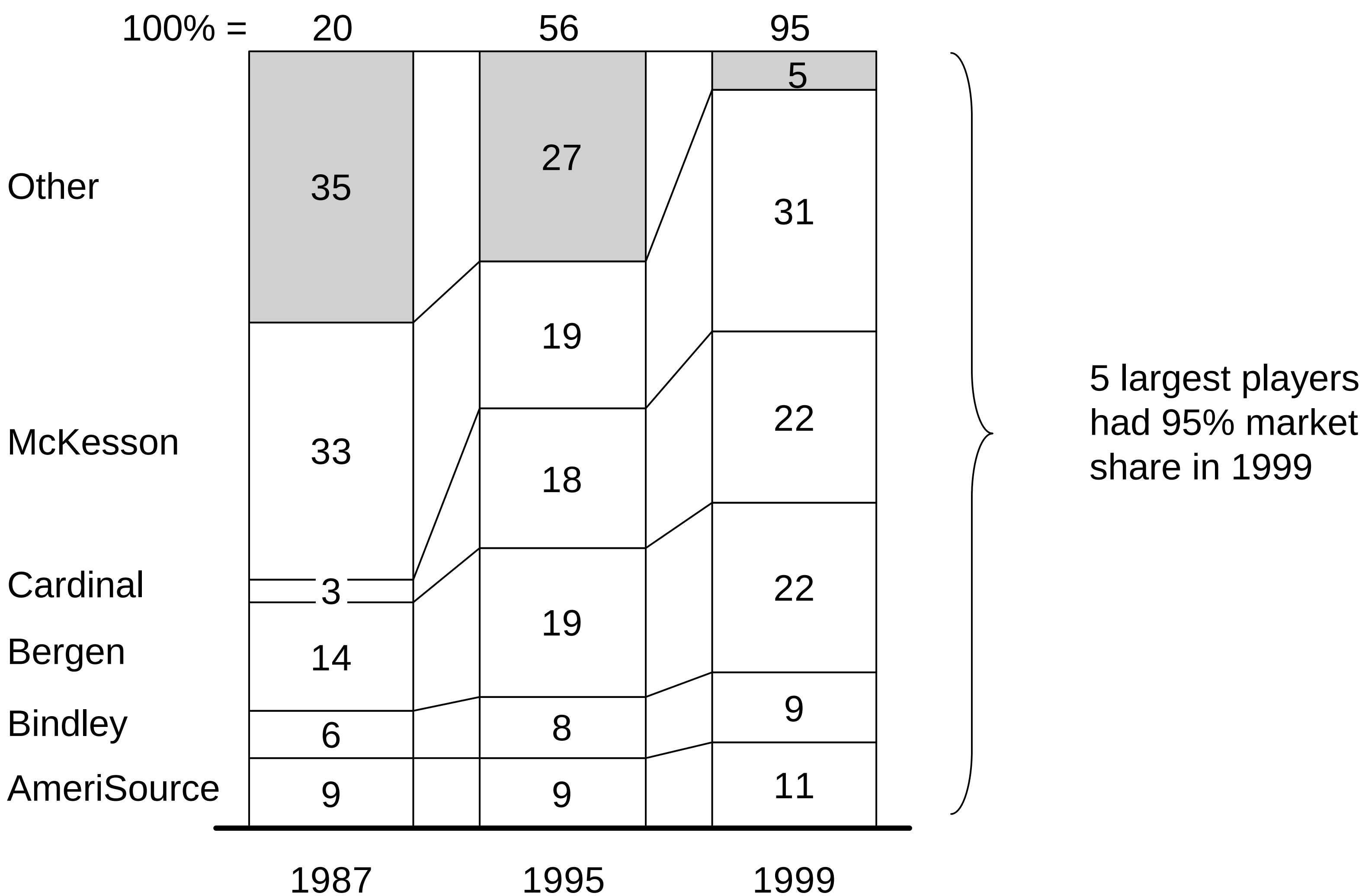
	1987-95	1995-99
Gross margin	-4.8	-4.8
Return on assets	-10.8	1.6

Source: NWDA

Exhibit 18

THE MOST SOPHISTICATED PLAYERS INCREASED MARKET SHARE

$ Billions; percent



Source: NWDA; 10Ks

Exhibit 19

TREND TO CONSOLIDATE AND MODERNIZE DISTRIBUTION CENTERS

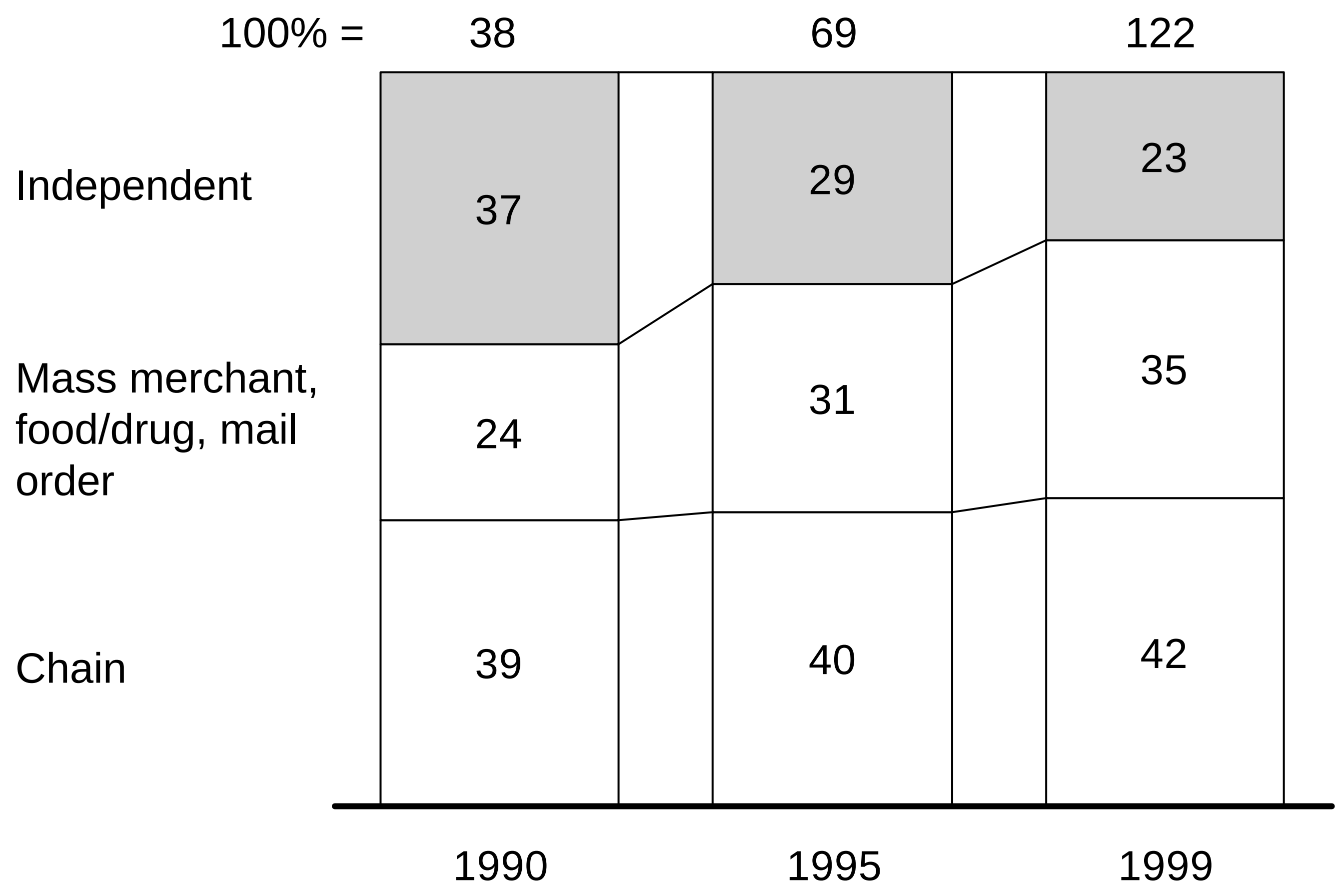
Year	Companies	Actions
2001	AmeriSource and Bergen	Plan to close 22 out of total 52 distribution centers (DCs)
1998	Cardinal Health	Accelerated the consolidation of several of its DCs and the relocation of others to modern facilities
1997	McKesson and Foxmeyer	Closed 18 out of total 57 DCs
1996	AmeriSource	Reduced DCs from 31 to 15 (by closing the older and less efficient centers and putting more volume into new high-tech centers)
1994	Bergen Brunswig	Has been consolidating its DCs over the past few years into larger regional DCs
1992	McKesson	Announced corporate-wide consolidation of distribution system and gradual rollout of automated "megacenters"
1991	McKesson	Created the industry's first paperless facility with implementation of MAPS (McKesson automated picking system)

Source: News releases

Exhibit 20

SHIFT IN PRESCRIPTION DRUG SALES AWAY FROM INDEPENDENTS

$ Billions; percent

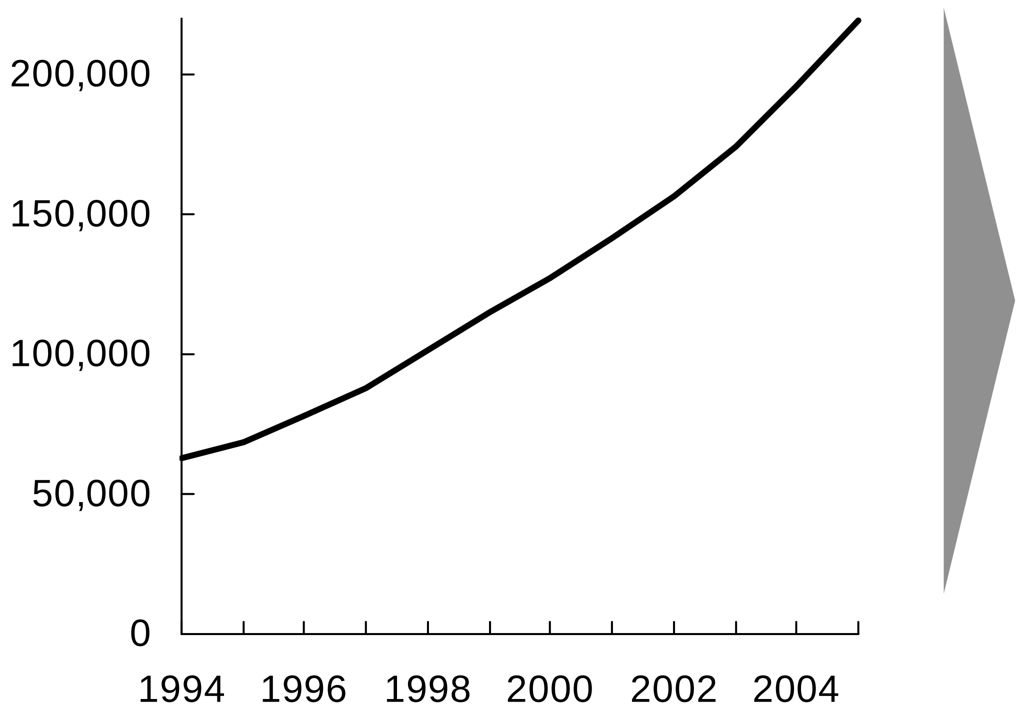


Source: IMS Health

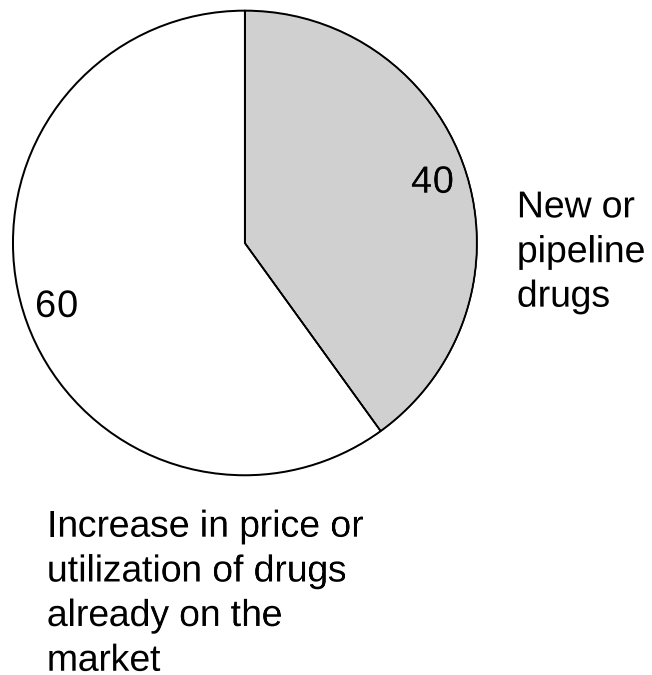
Exhibit 21

U.S. PRESCRIPTION DRUG EXPENDITURES WILL CONTINUE TO GROW

$ Millions



Factors influencing expected increase in expenditures

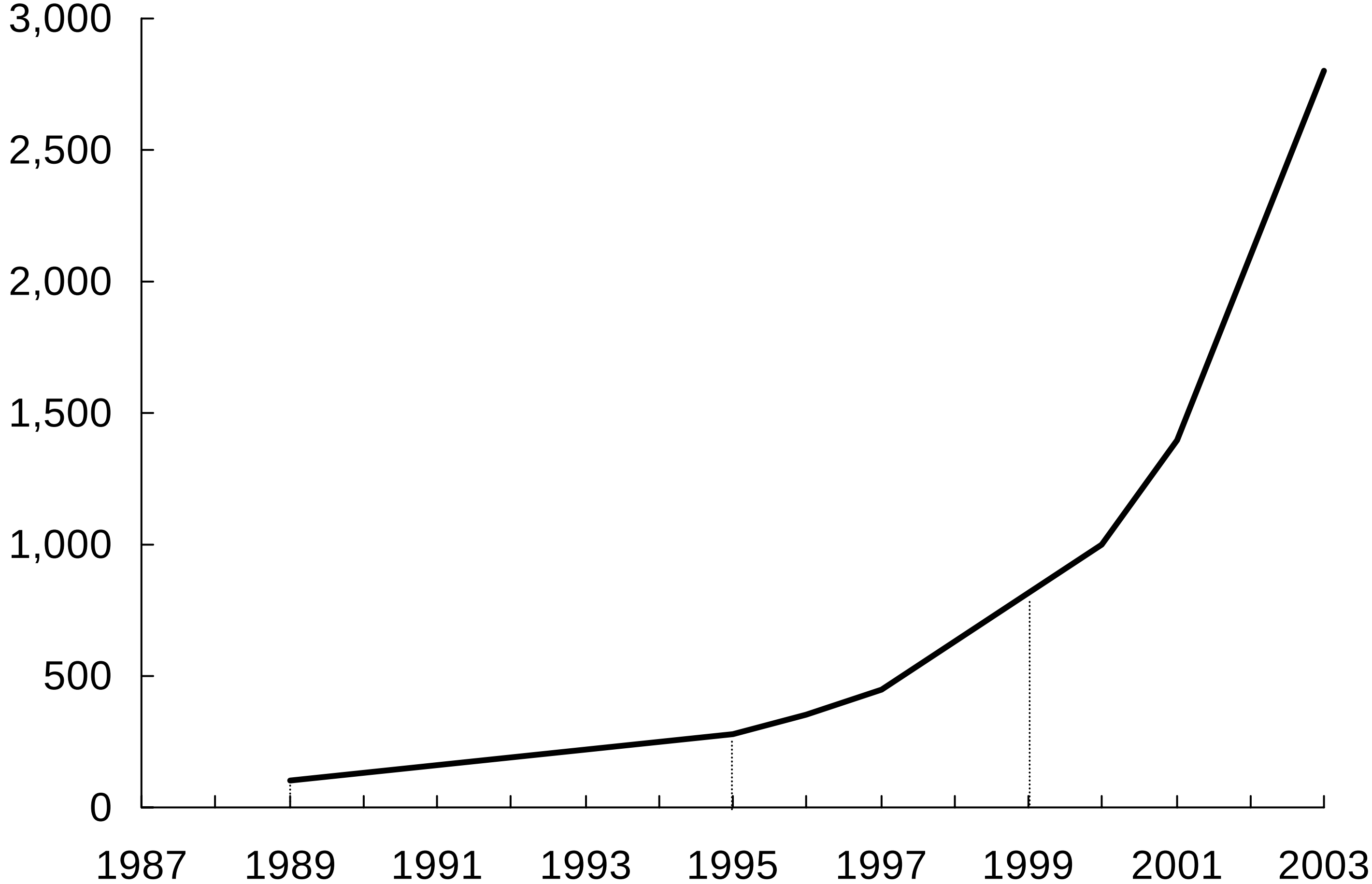


Source: Goldman Sachs; University of Maryland Study, 2000

Exhibit 22

WMS SALES GROWTH ACCELERATED POST-1995 AND WILL CONTINUE TO DO SO

$ Millions



Note: Wholesale accounts for 15% of WMS market; manufacturing and retail make up over 50% of demand

Source: AMR Research

Exhibit 23

IMPLEMENTATION RATE OF WMS BY MANUFACTURERS VARIES BY SUBSECTOR

Percent, 2000

Industry	Implemented	Plan to implement in foreseeable future
Food and kindred products	38	32
Textile mill products	25	28
Paper and allied products	24	35
Chemicals and allied products	25	31
Rubber and plastics products	26	25
Stone, clay, and glass products	22	23
Primary metals	18	24
Fabricated metals	19	25
Industrial machinery	18	19
Electronic/electric equipment	23	22
Transportation equipment	20	20

Comments

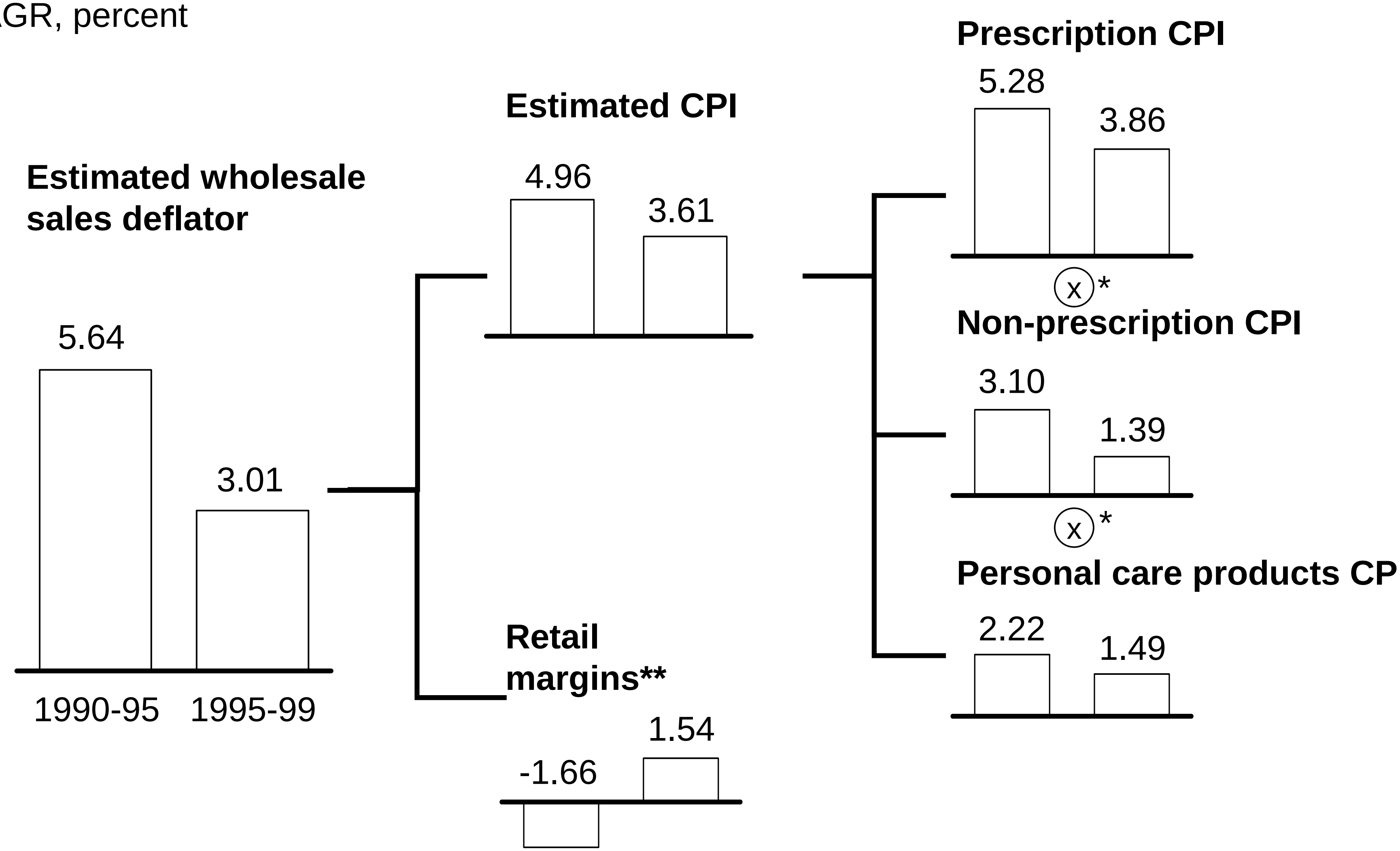
- Academics say there should be no obvious bias for more or less implementation in manufacturing than wholesaling
- Not all subsectors have the same potential
- Productivity growth spurred by warehouse automation is likely to be sustainable in other wholesale sectors

Source: *Industry Week* Census of Manufacturers

Exhibit 24

WHOLESALE SALES DEFLATOR CONSTRUCTION

CAGR, percent



* Calculation is (1 + growth rate 1) * (1 + growth rate 2)

** Margins are for drug stores

Source: BLS; BEA

Semiconductor manufacturing

SUMMARY

The semiconductor manufacturing industry has been at the center of discussion regarding the 1995-99 US productivity acceleration. This is partially because of the size of its contribution to that acceleration. Accounting for 0.20 of the 1.33 percentage point economy-wide productivity acceleration, it is the fourth-largest contributor. But the semiconductor industry's contribution is also particularly significant because of its relationship to Moore's Law. Moore's Law, an observation that the number of transistors semiconductor manufacturers can fit onto a single chip roughly doubles every 18 months, has been misleadingly hailed by many economists as the cause of much of the economy-wide productivity acceleration.

While Moore's Law can claim responsibility for the high productivity *growth rates* in semiconductor manufacturing, it cannot on its own explain the productivity *acceleration;* Moore's Law, by definition, predicts a constant level of performance growth – not an acceleration. Rather, the productivity acceleration resulted from an acceleration in the performance of the chips *shipped* per year. This may have resulted, in part, from an acceleration in the performance of the technology itself (a break from Moore's Law), developed at companies such as Intel. However, the more clear and significant cause was an increase in the frequency of new product releases, which moved the mix of chips purchased each year closer to the cutting edge.

This increased frequency in the release of newer chips (or shortening of the product life cycle) was a managerial response to changes in traditional market forces: a surge in competitive intensity, technological improvements in complementary industries, and an increase in demand. Most significantly, the rapidly intensifying competitive threat to Intel posed by Advanced Micro Devices (AMD) prompted Intel's managerial decision to release new products more frequently. This strategic, competitive decision to bring the market closer to the cutting edge was captured by a hedonic price deflator and, thus, flowed through to the productivity statistics.

MGI believes that most of the semiconductor manufacturing productivity growth exhibited from 1995 to 1999 will be maintained through 2005. For 2001-05, the growth rate of the performance of the basket of chips shipped will be maintained. Softening domestic unit demand for computers will however slightly drive down this sector's productivity growth. At least for the next 5 years, higher international unit demand should act to minimize the impact of lower domestic unit demand.

INTRODUCTION

Gordon Moore, a founder of Intel, once predicted that the number of transistors semiconductor manufacturers could fit onto a single chip would roughly double every 18 months. Moore's observation, subsequently dubbed "Moore's Law," captured the incredibly rapid rate of performance growth in semiconductors. This performance growth has significantly outpaced the costs associated with semiconductor production, causing many economists to note the potentially large repercussions of Moore's Law on productivity statistics. Governmental economic reports, including that of the US Congress' Joint Economic Committee[1], and popular economic commentaries[2] alike have touted Moore's Law as a clear contributor to the US productivity acceleration.

However, while Moore's Law can claim responsibility for the high productivity *growth rates* in semiconductor manufacturing, it cannot, on its own, explain a productivity *acceleration* in the industry. After all, Moore's Law, by definition, predicts a constant level of performance growth – not an acceleration. Therefore, the key question is whether the time cycle of Moore's Law shortened between 1995 and 1999, or whether, despite the continued validity of Moore's Law, subtler dynamics led to the performance acceleration of chips shipped each year. Our analysis indicates that while the former may share some responsibility, the latter most clearly caused the acceleration.

OVERVIEW OF SEMICONDUCTOR MANUFACTURING INDUSTRY

Semiconductor manufacturing represents approximately 0.16 percent of private sector employment and 0.73 percent of total value added (GDP) in the US economy. This makes it one of the highest-productivity sectors the McKinsey Global Institute (MGI) studied (Exhibit 1).

---

1 According to "Information Technology and the New Economy", released in July 2001 by Chairman Jim Saxton (R-NJ) and the Joint Economic Committee of the United States Congress, "Few question that IT production has exhibited phenomenal productivity growth. This is probably best illustrated in the case of semiconductors. In the 1960s Gordon Moore, the founder of Intel, predicted that microprocessor power would double every 18 months. The prediction was accurate enough that it became known as Moore's Law. Even accounting for R&D expenditures, the technological progress of the IT manufacturing sector has been remarkable and has contributed to the acceleration in labor productivity."

2 For example, dozens of magazines, newspapers, and on-line journals have quoted esteemed Northwestern University economist Robert Gordon's claim that, "What's sometimes called the 'Clinton economic boom' is largely a reflection of Moore's Law."

Industry profile

A semiconductor is a material that is neither a good conductor of electricity (like copper) nor a good insulator (like rubber). Chips using semiconductors include microprocessors, memory chips, and other analog and digital chips. These chips are used in a diverse range of electronic devices from cell phones to automobiles to computers.

The industry is characterized by a high concentration of market share. Though concentration varies from segment to segment, it is not unusual for three or four firms to account for half of the market or more. This concentration results, in part, from the high barriers to entry stemming from the industry's capital-intensive nature.

Importance of the semiconductor manufacturing sector to the overall question

Electronics manufacturing, of which semiconductors is a subset, contributed 0.17 percentage points to the overall US productivity growth jump of 1.33 percentage points, as measured by the US Bureau of Economic Analysis (BEA). MGI estimates that of the 0.17 percent industry-wide jump, semiconductor manufacturing contributed 0.20 percentage points, with the remaining subindustries in electronics manufacturing contributing negative 0.03 percentage points (Exhibit 1).

With a contribution of 0.20 percentage points, semiconductor manufacturing stands as the fourth-largest contributor to the US productivity jump, surpassed only by wholesale, retail, and security and commodity brokers. The majority of this contribution, 0.17 of the total 0.20 percentage points, came from a "within-sector contribution," or from the industry increasing its own productivity growth rate from 43.4 percent for 1987-95 to 65.8 percent for 1995-99. The less significant mix shift contribution, 0.03 of the total 0.20 percentage points, reflects a small acceleration in employment share toward this industry, which is approximately five times more productive than the overall economy.

The IT capital intensity growth of the electronics industry[3] accelerated 6 percentage points between periods, from 13 percent growth for 1987-95 to 19 percent growth for 1995-99.

---

3 BEA does not publish IT data for semiconductor manufacturing, but electronics manufacturing serves as a good proxy.

LABOR PRODUCTIVITY PERFORMANCE

Using the sources and methodology described below, MGI calculated that the industry increased its own value-added productivity growth rate from 43.4 percent for 1987-95 to 65.8 percent for 1995-99.

The calculated real value-added contribution for semiconductor manufacturing reflects an adjustment for quality improvements in the industry's output. For semiconductors with distinct performance specifications, such as microprocessors, the adjustment is made by using a hedonic function of several performance characteristics to calculate the price deflator. The hedonic deflator for microprocessors adjusts for the relative pricing of different amounts of transistors, instructions per second, clock speed, coprocessors, and several other factors determining performance (see Appendix A, Exhibit 2).

The BEA does not explicitly publish a real value-added contribution for microprocessors or semiconductors – only for electronics manufacturing, which contains both. Consequently MGI constructed its own productivity measurement for semiconductors (Exhibit 3).

- ¶ MGI used National Bureau of Economic Research (NBER) and nominal data from the US Census Bureau in measuring the semiconductor manufacturing productivity jump (Exhibit 4).
- ¶ The semiconductor input deflator used in MGI's calculation was provided by the NBER while the Bureau of Labor Statistics (BLS) provided the semiconductor output deflator. This is the identical output deflator used by the BEA when creating its electronics price deflator (see Appendix B).
- ¶ The lack of nominal data for US microprocessor production prevented MGI from explicitly measuring microprocessor productivity.[4]

The semiconductor price deflator used by the BEA is slightly unusual as it is a hybrid (of sorts) of price and performance measurements made by the BEA and the BLS. MGI's measurement uses the same deflator employed by the BEA and hence, should approximate the jump embedded within electronics manufacturing. However, it is worth noting that there are inconsistencies in the "baskets of microprocessors" chosen by the BEA and the BLS to construct the microprocessor price index, which is used to construct the overall semiconductor price deflator. The basket used for measurements through 1996 is composed of a set of semiconductors that, all things being equal, exhibits performance improvements at

---

4 Given the industry's concentration, MGI considered constructing a microprocessor productivity measure by conducting a firm-level analysis. Unfortunately, it is difficult to separate out Intel's or AMD's various operations and employment by country.

a slightly faster rate than those in the basket used after 1997. Hence, the measured productivity acceleration should serve as a lower bound for the size of the actual productivity jump in semiconductor manufacturing (see Appendix B).

EXPLAINING THE JUMP IN 1995-99 LABOR PRODUCTIVITY GROWTH

The bulk of this case focuses on understanding the drivers of the acceleration in output performance (as manifested in the output deflator). The magnitude of the acceleration in output performance growth overshadowed more traditional sources of labor productivity gains, such as the replacement of labor with technology or the ability to scale volume without adding employees. For example, while increasing the firm-level focus on yield management (including the application of better process management equipment) contributed to the productivity acceleration, it did not do so by eliminating the already limited number of personnel engaged in production. Rather, these technical and operational firm-level factors enabled the acceleration in new product introductions,[5] which helped drive performance growth in the industry's output and, in turn, led to a labor productivity jump.

Focus on the microprocessor subsector

The semiconductor productivity jump results from the significant jump in the industry's value-added deflator (Exhibit 3). It is clear that this reflects an acceleration in performance growth, rather than in price decline, as rates of price decline did not fluctuate at such large magnitudes. In fact, comparing price and performance data for Intel's high-end microprocessor shipments[6] from 1995 to 1999, it is clear that jumps in performance metrics such as millions of instructions per second (MIPS) and transistors per chip do indeed drive the acceleration (Exhibits 5 and 6).

Further, this productivity jump in the microprocessor industry seems to be the primary driver of the entire semiconductor industry's productivity jump. Comparing the output deflators of the various semiconductor subsectors, it is clear that only memory (primarily dynamic random access memory or DRAM) and microprocessors exhibit performance-adjusted price changes large enough to cause those in the industry-wide deflator (Exhibits 7 and 8). Further, one sees that the

---

5 This seems consistent with an argument in "Information Technology and the US Economy" by Dale Jorgenson of the Harvard Institute of Economic Research. Referring to an acceleration in the decline of performance-adjusted semiconductor prices (i.e., a drop in price for given performance or a jump in performance for a given price), he explains that, "the recent acceleration … can be traced to the shift in the product cycle for semiconductors from 3 years to 2 years that took place in 1995…."

6 This data does not include the Intel Celeron processor, Intel's lower-end chip. This should not materially impact our conclusion, as the Celeron did not have significant market share until the very end of the studied time period.

jumps in the microprocessor deflator (particularly those occurring in 1995 and 1998), line up perfectly with those in the deflator for all of semiconductors.

Though the DRAM deflator also approximates the semiconductor deflator's movements reasonably well (and best approximates its magnitude), one notices that the major jumps do not line up. This indicates that the DRAM industry is not a major contributor to the jump in US semiconductor manufacturing productivity (Exhibit 8). This is not particularly surprising since worldwide production of semiconductors is unevenly distributed, and most DRAM production left the US prior to 1987.[7] Many semiconductors (such as DRAMs) are cheaper to make abroad, while others (such as microprocessors) are still produced in the US for strategic and logistical reasons (e.g., proximity to key employees and labs). Further verification that DRAM production's contribution to the overall industry is small lies in the fact that the DRAM deflator's sharp movements in 1996 and 1999 had little impact on the semiconductor deflator.

Given the importance of the microprocessor subsector to the semiconductor manufacturing industry, MGI also studied Intel's market behavior and competitive dynamics, as it is the key microprocessor player in the US. The US microprocessor industry is extremely concentrated, with two firms, Intel and AMD, accounting for over 90 percent of the microprocessors produced for use in computers. Though Intel's market share was only about 50 percent in 1987, it remained relatively stable at 80 percent from 1995 to 1999.

Firm-level ("operational") factors

Three firm-level factors, led by Intel, contributed to the productivity growth acceleration in microprocessors (Exhibit 9).

Increased frequency of new chip releases. Intel, responding to a competitive threat from AMD, made a strategic managerial decision to increase the frequency of new chip releases (defined roughly as any chip available to computer manufacturers that offered a greater number of megahertz, instructions per second, or transistors)[8], or put differently, to reduce its product life cycle. Essentially, Intel wanted to ensure that at any given time, it had the most powerful chip available on the market. In addition, this may have reflected efforts to better segment the market and maximize supplier surplus. This change in market strategy was the mechanism causing a shift in the industry's output mix toward the cutting edge, resulting in a performance acceleration captured in the deflator.

---

7 According to S.G. Cowen, "By the mid 1980s, Japan was producing the vast majority of the world's DRAM, and most of the US companies exited this commodity-like market."

8 It is true that Intel may be able to produce a virtually identical chip design and still run the chip at a higher clock speed. In this context, however, this should be considered a new chip since end-users (making the purchasing decision) will favor it over slower-clocked chips, and its performance increase will also be captured in the deflator.

In describing this dynamic, MGI does not focus on the possibility that there has been a change in the time cycle of Moore's Law. Robert Gordon recently noted that Gordon Moore himself believes that sometime before the end of 2000, a shortening in this time cycle had indeed occurred.[9] While this may be true and hence, may have contributed to the productivity acceleration[10] – brief inspection suggests that it may have only occurred toward the end of the 1987-99 period, or perhaps subsequent to this time period (Exhibit 10). Rather, MGI focuses on the assertion that as the lag time decreases between successive generations of chips, the "basket of chips" shipped accelerates toward the cutting edge, getting closer to the frontier described by Moore's Law (Exhibit 11). The mechanism by which a greater frequency of chip introduction causes performance acceleration can be explained as follows:

¶ The percentage of current and previous generation chips in the "basket" does not change, but previous generation chips are not as far from the performance of current chips (i.e., a mixed basket of 386s and 486s is not as current as a mixture of Pentium II 300s and Pentium II 333s), or

¶ By allowing more frequent upgrades to the cutting edge, the mix of products in the basket shifts toward more recent chips, or

¶ Both (Exhibit 12).

Though Intel's strategy was facilitated by an improvement in the economics of new chip production (see below), this shortened product cycle did cut into Intel's (and the industry's) margins. However, due to increasing competition, Intel made a managerial choice to sacrifice a bit of its margin to ward off market share loss to AMD.

Shortened time-to-yield. Microprocessor manufacturers also improved their abilities to achieve economically viable yields faster in the 1995-99 period than in the 1987-95 period. This resulted from a number of trends that occurred in the early to mid 1990s, including more powerful simulation, more reliable semiconductor manufacturing equipment, faster wafer inspection technologies[11], and a general intensification of the industry's focus on bringing their designs to market more quickly. By decreasing the time to yield (or accelerating the fab

9 Gordon, Robert, "Technology and Economic Performance in the American Economy"

10 It is quite difficult to verify or refute this hypothesis for two reasons. First, microprocessor "performance," as measured by the BEA's hedonic deflator, relies on many variables – not just transistors – and accurate market data for all the required parameters are quite difficult to find. Second, the calculation of performance growth rates is extremely sensitive to the chosen endpoints because performance improvements are introduced to the market in large steps.

11 Metrology companies began to offer new testing, inspection, and other yield management hardware, which allowed for testing at significantly greater speeds than was previously possible. Able to test their chips with a greater throughput, semiconductor manufacturers began to test a higher percentage of their chips at more phases in the production process. This increased frequency of inspection allowed manufacturers to more quickly and effectively hone in on and correct the source of the damage to the chips.

ramp-up rates), manufacturers could more quickly produce a new chip design or use a new machine at an acceptable yield. This, in essence, softened the negative impact of the shortened product life cycle on manufacturers' margins. For related details about the microprocessor manufacturing process, see Box 1.

Box 1

THE MICROPROCESSOR MANUFACTURING PROCESS

Microprocessor manufacturing involves processes that are incredibly sensitive to disruptions from the environment (dust particles, etc.), flaws in the chip design, faulty steps in the fabrication process, and suboptimal designs of a number of other production factors. These sensitivities lead to tremendous variance in a production line's yield, the number of "good" (i.e., sellable) chips per wafer start.[12]

A semiconductor manufacturing company can always produce a significantly different chip, or use a smaller line width,[13] but the process yield will initially be too low to be economically feasible. The real challenge in moving to a new design, therefore, is being able to produce the new design at a high enough yield (generally speaking, 70 percent to 90 percent or better). Typically, the manufacturing process for a new chip will undergo many iterations of testing and adjustment, aimed at bringing the process up to acceptable yield rates.

Amortization of R&D and fixed labor. Finally, given the acceleration in unit demand, microprocessor manufacturers were able to more quickly amortize R&D and other fixed labor costs. This both allowed them to justify the huge fixed costs required from each new chip design (and hence, to increase the frequency of new chip release), as well as to reap an acceleration in labor productivity in the form of labor economies of scale.

Industry-level factors

A number of firms have vigorously pursued Intel in the microprocessor market – most notably AMD. Throughout the late 1980s and early 1990s, Intel's technological and manufacturing capabilities positioned it as the clear industry leader. However, fierce competition from AMD toward the late 1990s threatened Intel's ability to maintain its technology lead. AMD posed a substantially greater competitive threat to Intel during the 1995-99 period than the 1987-95 period. Indeed, this increase in competitive intensity was the single most direct and potent factor prompting Intel's (and the whole industry's) reduction in the length of product life cycles (Exhibit 13).

---

12 Each wafer, depending on the wafer size, chip design, and line width, can hold hundreds of chips or more.

13 The line width, or design rule, is essentially the "pixel size" of a chip, determining how closely elements of the microprocessor, such as transistors, can be placed together.

AMD licensing agreement with Intel. Prior to 1996, AMD operated under a disputed licensing agreement under which AMD could produce several of the 80X86 chip designs and pay royalties to Intel. Further, given Intel's position as market leader, AMD designed its proprietary chipsets to be fully compatible with Intel's. To ensure this compatibility, AMD did not aim to release a given generation of chips until Intel set the standard. However, in January 1996 the disputed operating agreement was settled and AMD maintained its right to manufacture several of Intel's chip architectures. This situation propelled Intel to focus on new designs on which AMD had no legal claims.

Increased AMD capabilities. Also in 1996, AMD made a push for a more robust design capability of its own by purchasing a microprocessor developer, NexGen. At this time, the firm began working on a faster generation of microprocessors to compete with the Pentium – the K6. AMD's efforts to match Intel's technology were manifested in a rapidly diminishing time lag between Intel and AMD's release of comparably performing microprocessors. While the technology gap was over 18 months in 1995, AMD and Intel were competing neck and neck by 1999.

External factors

Computer manufacturing experienced a small acceleration in demand for overall units sold between the 1987-95 and 1995-99 periods (see "Computer Manufacturing" case), buoyed by several factors in the external environment. First, there was a general increase in computer penetration into homes and businesses. In addition, the period brought increased upgrade activity to higher-performance computers that were able to run the ever more complex Windows operating systems (Windows 95, in particular) and were current enough to be Y2K compliant[14]. Finally, as discussed earlier, advances in chip manufacturing processes enabled manufacturers to get more cutting-edge chips to the market faster.

Increased penetration of PCs. The tremendous growth in the use of computers, prompted in part by the rapid penetration of e-mail and the World Wide Web, resulted in an acceleration in demand for units of computers from 13.1 percent growth in 1987-95 to 17.1 percent in 1995-99.

Increased PC upgrade activity. The microprocessor performance requirements (measured in megahertz) of various software packages, most significantly those of the Windows operating systems, accelerated during the 1995-99 period (Exhibit 14). The increasing need for more powerful computers to run the more complex

---

14 The Y2K (year 2000) problem, or the millennium bug, resulted when computer systems were unable to cope with the year changing to 2000. Many computer owners, in anticipation of problems on their systems, preemptively upgraded to newer systems that would not have difficulties with the transition.

operating systems fueled a demand for more frequent microprocessor releases to allow users to be closer to the cutting edge. Simply put, there was increasing incentive for a microprocessor company to offer, at any given time, the most powerful chip on the market. This mix shift of the output toward the cutting edge also feeds a virtuous cycle with software vendors – better chips allow computer manufacturers to accommodate an acceleration in the system performance requirements of various software packages, shifting the output mix even further.

Improved manufacturing processes. In the early to mid 1990s, the semiconductor manufacturing equipment industry and the wafer inspection and testing equipment industry made several technological improvements which, complemented by increased industry focus on reducing ramp-up times, allowed semiconductor manufacturers to achieve better yields and process designs in less time. These technologies enabled the firm-level strategy changes discussed earlier, such as the shortening of the time period between new product releases.

OUTLOOK 2001-05

MGI estimates that the growth rate in semiconductor manufacturing will slow from the 1995-99 clip of 66 percent per year to a 2001-05 level of 60 percent per year (Exhibit 15). This would imply that the within sector contribution to the aggregate productivity growth for semiconductor manufacturing will fall from 0.43 to 0.40 percentage points while the mix shift contribution will move from 0.01 to approximately -0.01 percentage points. The result is that the sector's overall contribution to the aggregate productivity growth will fall from the 1995-99 level of 0.44 to 0.39 percentage points for 2001-05 (Exhibit 16).

¶ MGI estimates that the growth in performance of the basket of microprocessors sold should be sustainable (Exhibit 17). The industry can achieve such performance even if Moore's law continues at its historic rate and product lifecycles remain constant. Barriers to the continuation of Moore's Law at least at its historic rate should be overcome given the competitive incentives do so, and product life cycles for cutting edge chips are unlikely to lengthen. Intel's public statements about future chip releases through 2002 and potential transistors per chip in 2007 suggest that the industry may be able to do even better than these base assumption. Consequently, improvement at 1995-99 rates (implying continuation of the 1995-99 semiconductor deflator growth rate) appears a conservative assumption.

¶ The rate of growth of unit demand from 2001-05 will be slower than it was over the earlier two periods. Specifically, domestic unit demand will fall to 3 percent per year growth. (See Computer Manufacturing case.) Even if international unit demand continues at its 1995-99 growth rate of

17 percent per year, this will mean an overall unit demand growth of only 10 percent per year for the next 5 years.

¶ The last key parameter behind our sustainability estimate is the assumption that employment will remain flat, or exhibit zero percent growth. In addition to the fact that a relatively large percentage of the semiconductor manufacturing workforce is fixed, MGI notes that many industry forecasts predict flat or declining revenues. Initial observations indicate that in such an environment, companies will not attempt to expand their workforce.

Alternatively, we can attribute the projected drop in the 0.44 percentage point contribution to the 1995-99 aggregate productivity growth to two different factors (Exhibit 18):

¶ Unsustainable 1987-95 base contribution of 0.03 percentage points due to drop in unit growth to 10 percent annual growth.

¶ Unsustainable 1987-95 base contribution of 0.02 percentage points due to mix shift effects from additional reduction of labor in a highly productive sector.

Note that all of the contribution to the aggregate productivity growth jump of 0.20 percentage point is sustainable, since the performance growth of the basket of semiconductors, the main driver of the jump, will continue to grow at its 1995-99 rate. This again results in a 2001-05 sustainable contribution to the aggregate productivity growth of 0.39 percentage points.

APPENDIX A: THE HEDONIC DEFLATOR

A hedonic deflator is a gauge economists use in order to quantify the functional capacity of certain goods whose performance or function changes over time. The use of hedonic deflators is most appropriate when there is a strong relationship between a good’s performance and its price. This essentially allows economists some manner in which to separate out performance improvements, which alter the price, and hence, to determine how performance-adjusted prices are changing. Hedonic deflators are frequently used in high technology industries such as computers and semiconductors, as well as for goods such as automobiles and for certain types of health care.

The weights used to measure the performance characteristics result from hedonic regressions. These are essentially multiple regressions of price data with variables representing various characteristics of the good. For microprocessors, such characteristics included age, clock speed, transistors, registers, and MIPS. The regression essentially calibrates the value of each performance characteristic based on the historical price data. Once the value of each characteristic (or combination of characteristics) is determined, one can determine a good’s performance-adjusted price.

APPENDIX B: THE "HYBRID" MICROPROCESSOR AND MEMORY CHIP DEFLATORS

The BEA constructed its own price deflator for microprocessors and memory chips from 1987 to 1996 and this data was, in effect, concatenated with the BLS's respective price indices from 1997 to 1999.[15] These "hybrid" deflators were then combined with other BLS price indices (such as transistors) using Fisher ideal weights to create the semiconductor output deflator.

The "basket of microprocessors" surveyed by the BEA 1987-96 were almost entirely destined for computers while the basket used by the BLS for 1997-99 included embedded microprocessors (for automobiles, etc.). As performance growth in embedded microprocessors is significantly slower than that in computer microprocessors[16], one can think of the first period's rate of performance improvement as an upper bound. Given that the productivity acceleration was caused by an acceleration in this rate of performance improvement, one might assert that the BEA's measurement slightly underestimates this sector's jump.

---

15 The BEA used a 1996-97 growth rate that was provided by the BLS to concatenate Bruce Grimm's price indices for microprocessors and memory chips through 1996 with the BLS's 1997-1999 price indices. MGI did not have access to this 1996-97 growth rate and hence, simply extrapolated Grimm's 1995-96 rate to 1997. This data was then joined with the BLS data to form the deflator. This methodology was only used to construct the two price indices to make qualitative comparisons to the semiconductor deflator. This adjustment did not impact any MGI measurements.

16 Anecdotal evidence confirms that microprocessors produced in the early 1990s are still used in automobile production. It is clear that the same cannot be said of microprocessors currently used in computer assembly.

CONFIDENTIAL

The Semiconductor Industry

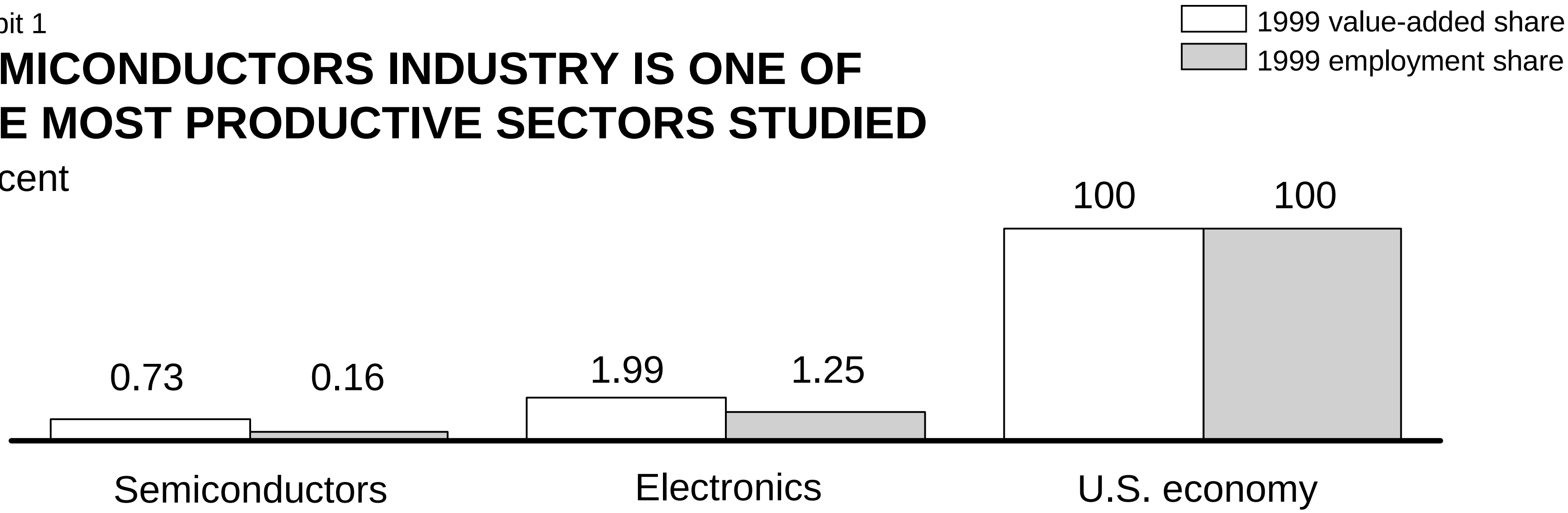
MGI/HIGH TECH PRACTICE NEW ECONOMY STUDY

October 3, 2001

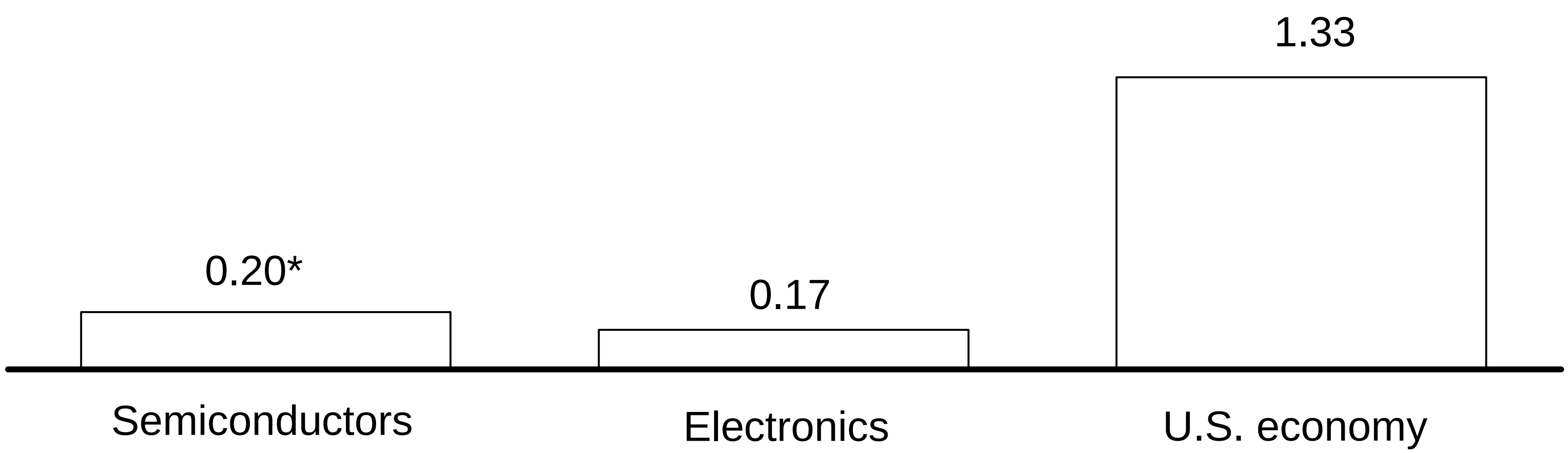
Exhibit 1

SEMICONDUCTORS INDUSTRY IS ONE OF THE MOST PRODUCTIVE SECTORS STUDIED

Percent



Contribution to 1995 aggregate productivity growth jump



* 0.03% due to the mix shift

Source: Census; BEA; MGI analysis

Exhibit 2

MICROPROCESSOR DEFLATOR IS GENERATED WITH HEDONIC FUNCTIONS

- The microprocessor deflator reflects changes in both price and performance
- Performance measured by BEA (1987-96) as combination of Mhz, MIPS*, internal register bits, external bus bits, transistors, memory, cache, and other variables
- Performance measured by BLS (1997-99) as combination of maximum integer and floating point executions per second
- We define $\Delta\Pi$ as the percentage change in chip performance and ΔP as the percentage change in chip price. Hence, the rate of change in the deflator should be approximately

$$\Delta deflator = \frac{(1 + \Delta P)}{(1 + \Delta \Pi)} - 1$$

MGI looked for accelerations in the rate of change of both the price and the performance per chip in order to explain the movement of the deflator

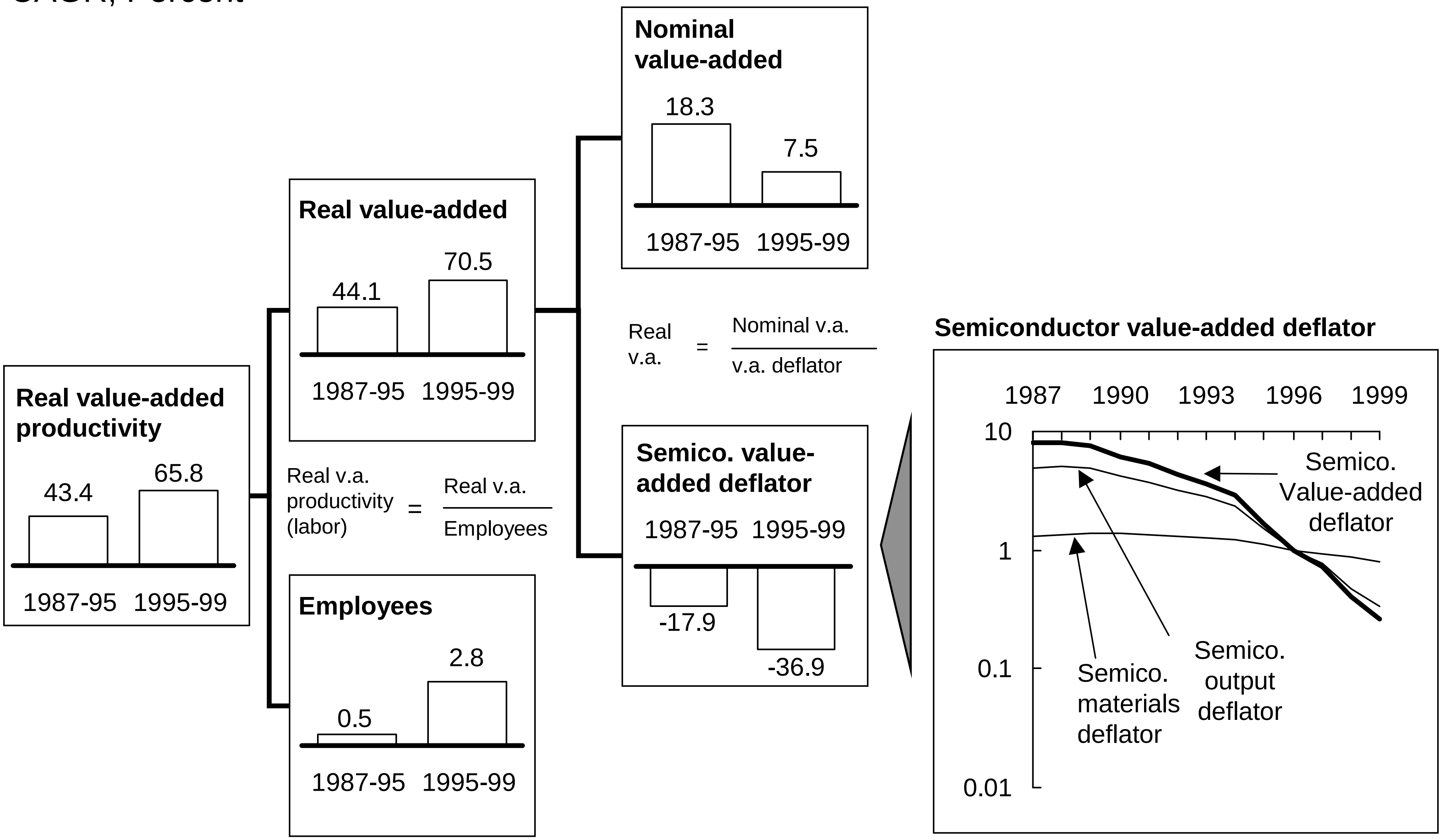
* Millions of instructions per second

Source: BLS interviews; MGI analysis

Exhibit 3

HOW MGI CALCULATED SEMICONDUCTOR INDUSTRY VALUE-ADDED PRODUCTIVITY

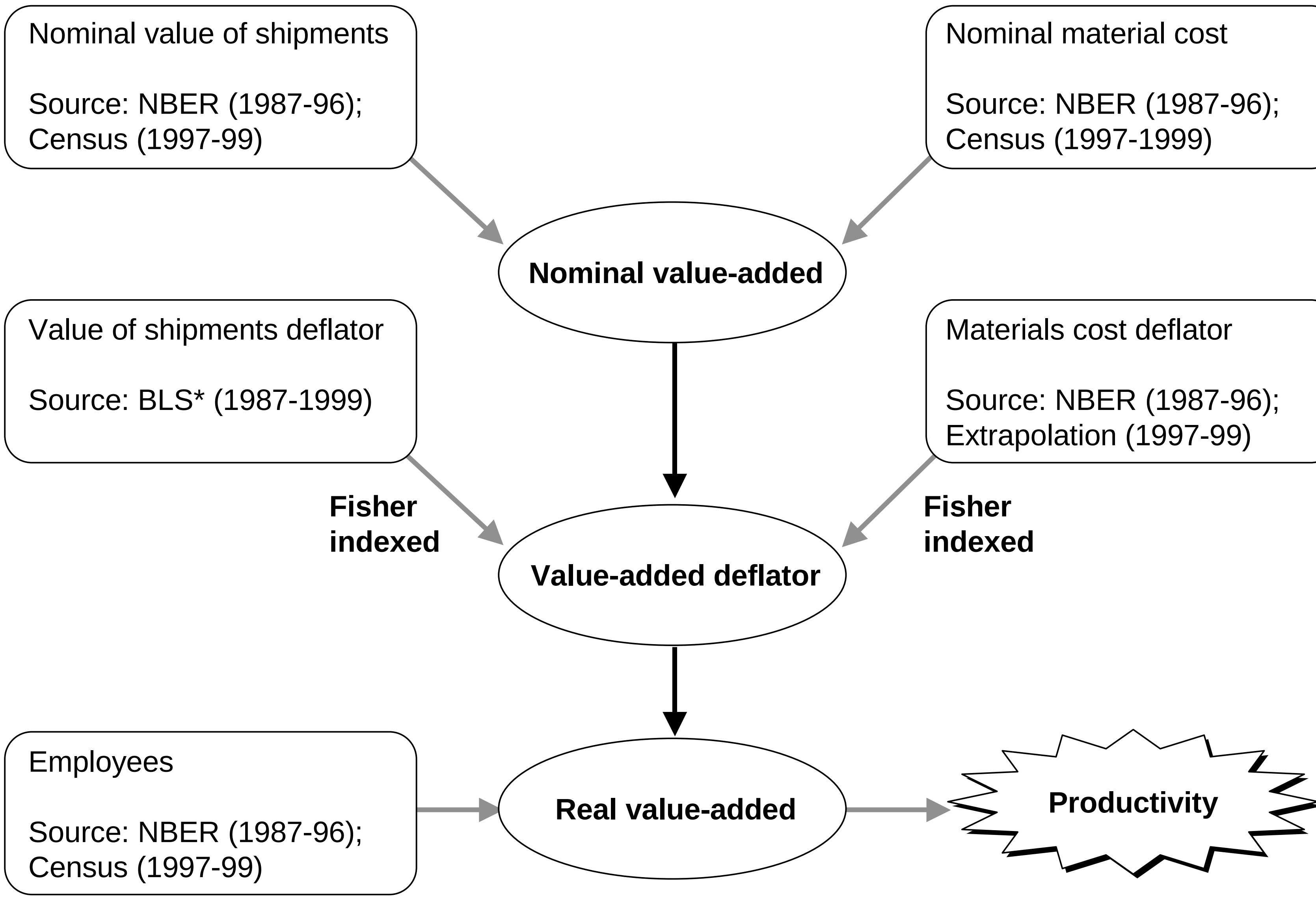
CAGR; Percent



Source: BLS; Census of Manufacturing; NBER; MGI analysis

Exhibit 4

HOW MGI MEASURED SEMICONDUCTOR MANUFACTURING PRODUCTIVITY

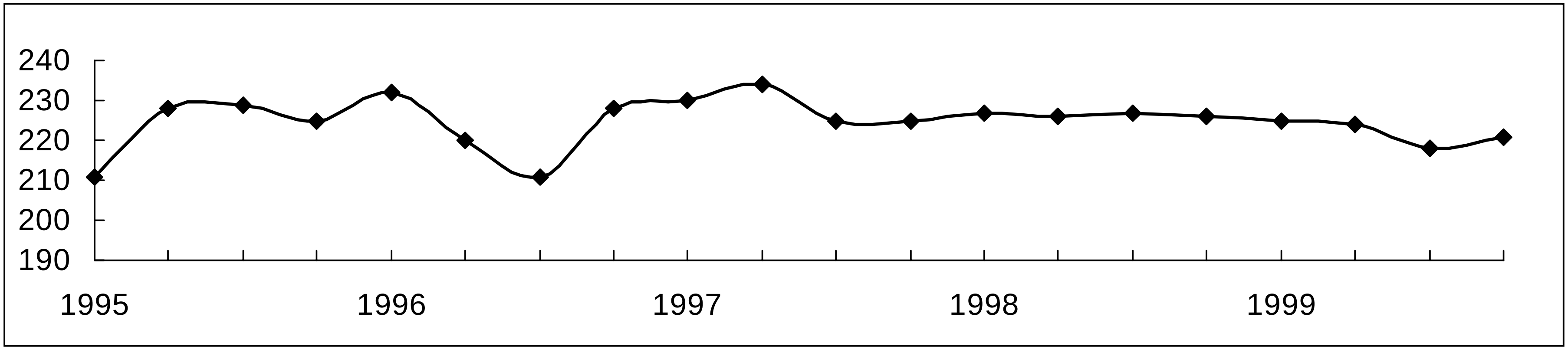


* BLS received deflator from GPO group at BEA, who adjusted BLS PPIs with price research done by Bruce Grimm

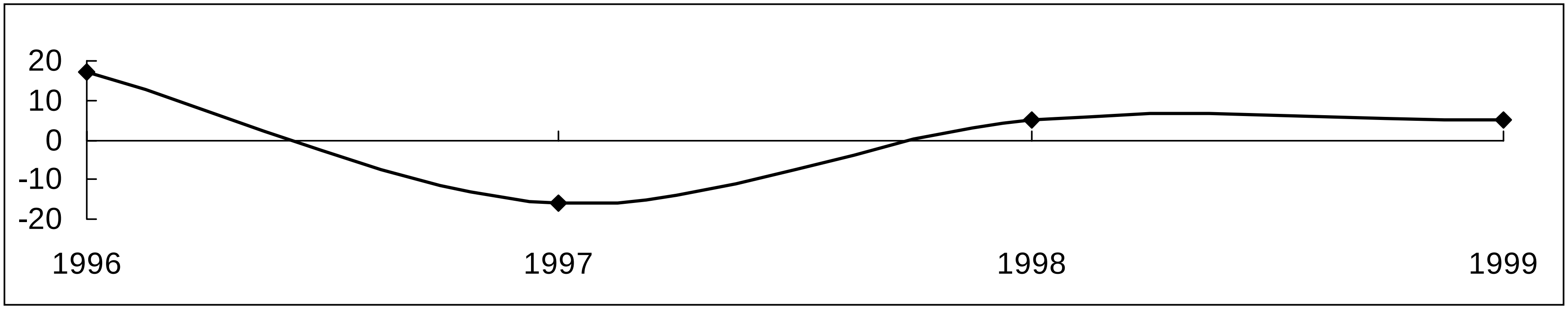
Exhibit 5

NOMINAL PRICE OF MICROPROCESSORS REMAINED RELATIVELY CONSTANT

Average price per Intel chip shipped*
Current dollars



Fisher indexed rate of change in price*
Percent



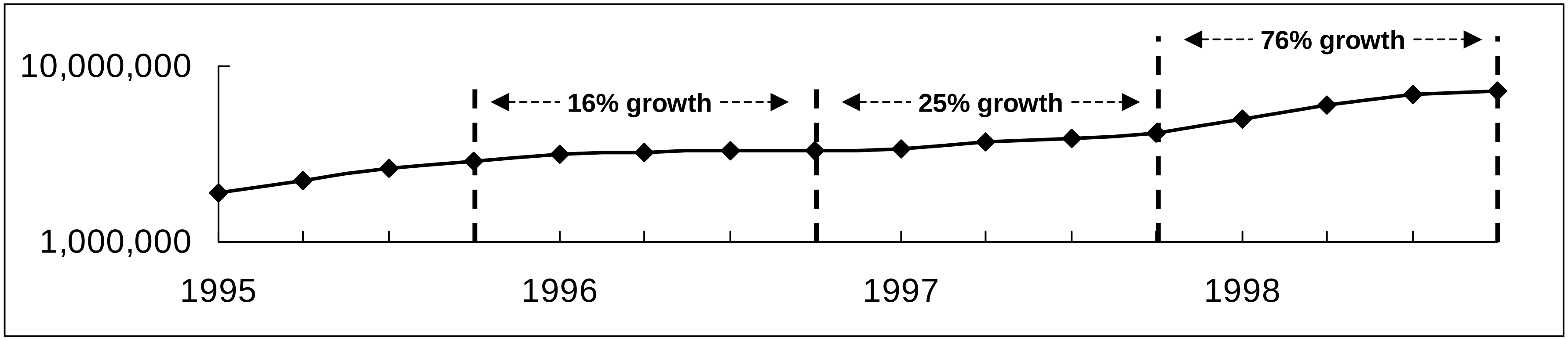
* Excludes Celeron and other low-end processors

Source: Intel Microprocessor Forecast; Intel; MGI analysis

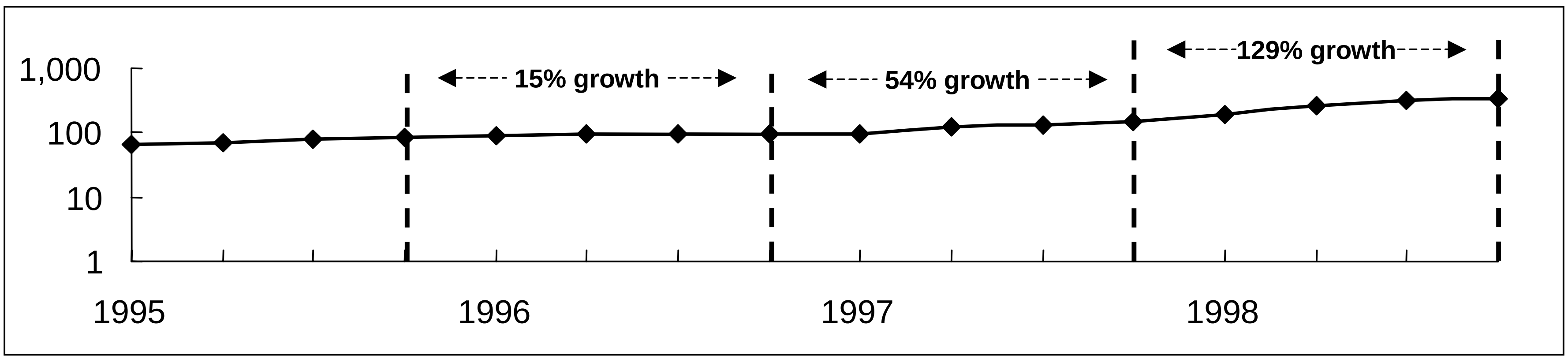
Exhibit 6

PERFORMANCE OF BASKET OF CHIPS SHIPPED ACCELERATED, 1995-98

Transistors per Intel chip shipped*



MIPS per Intel chip shipped*

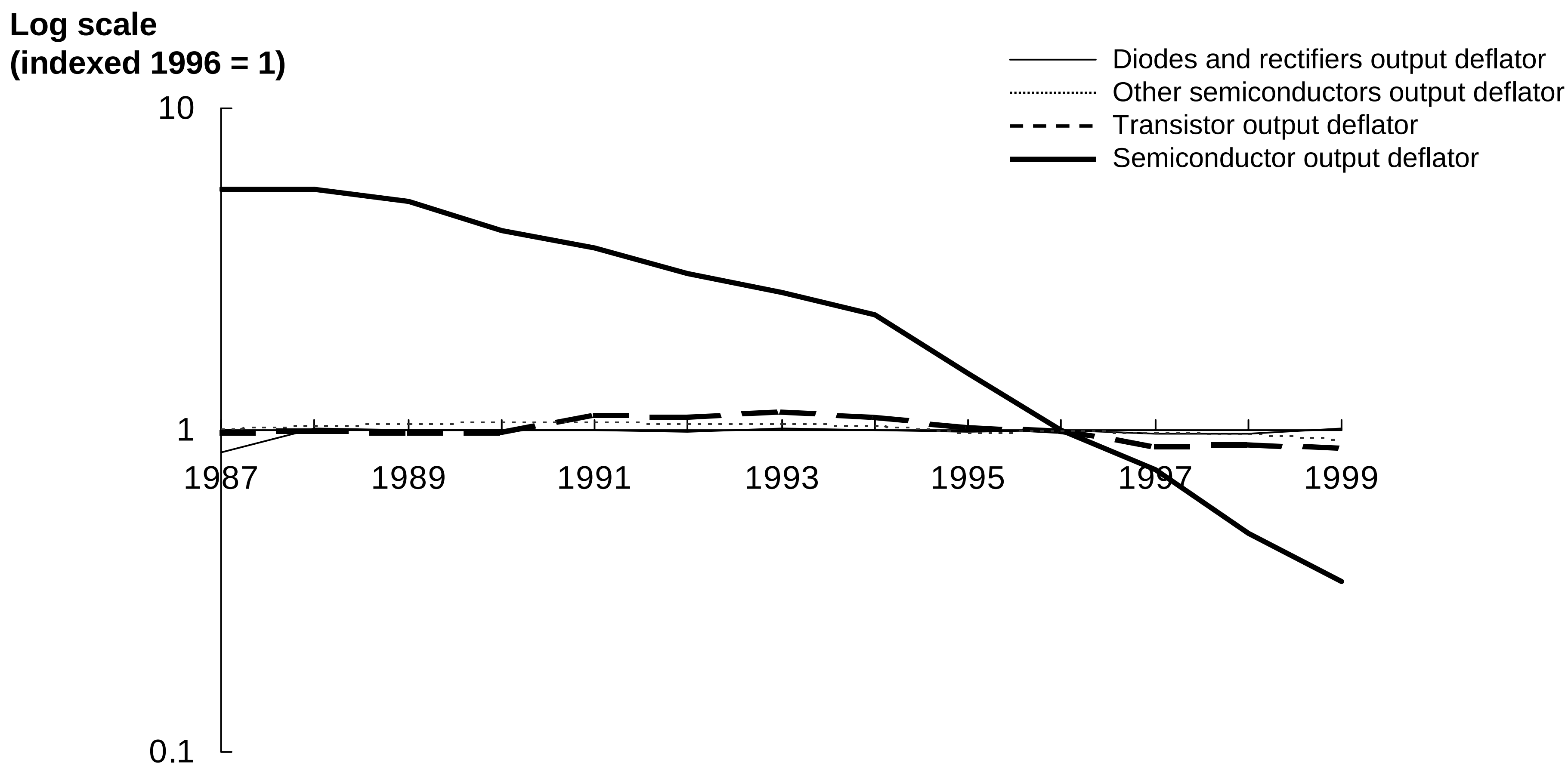


* Excludes Celeron and other low-end processors

Source: Intel; MGI analysis

Exhibit 7

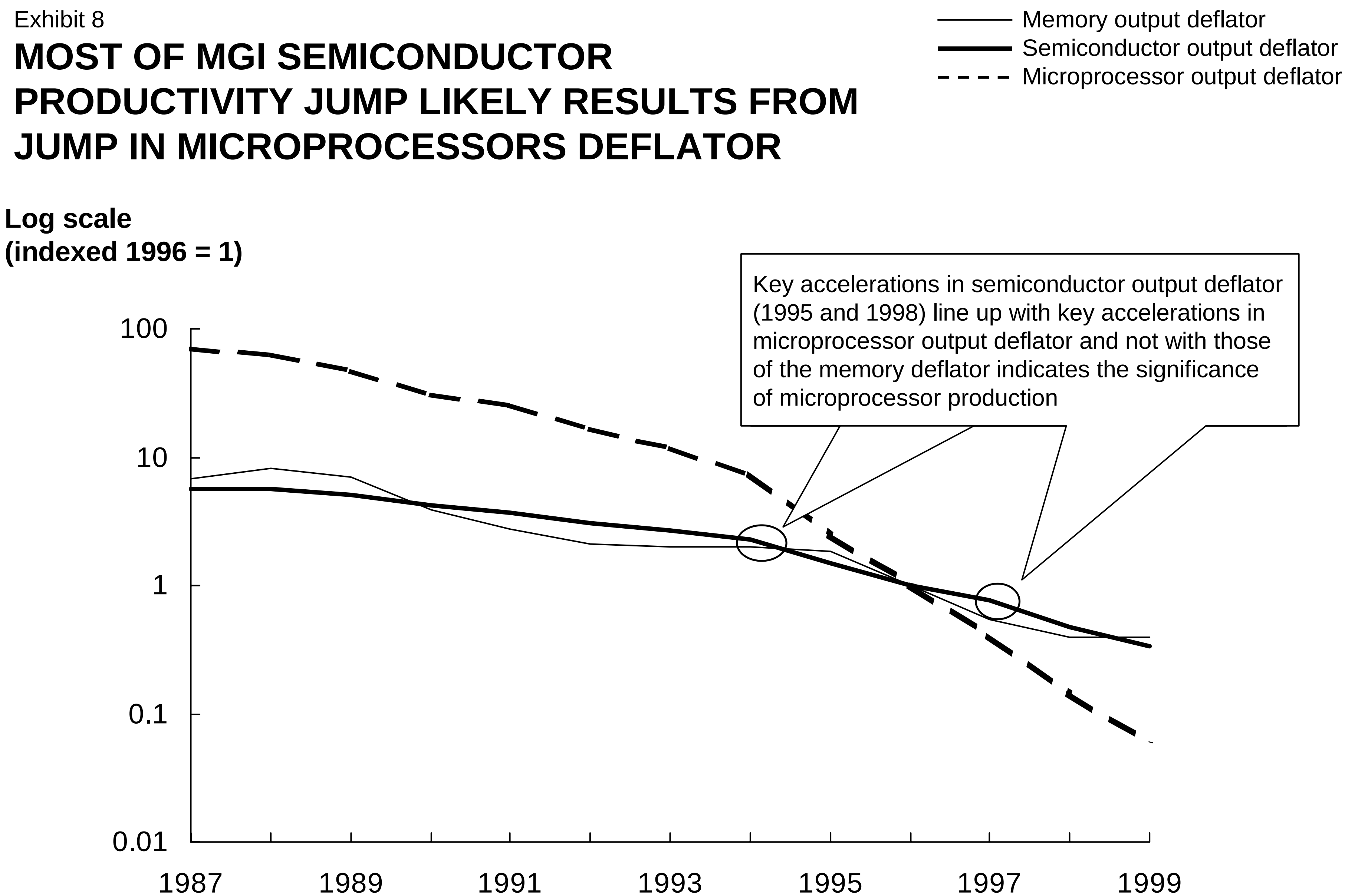
DIODES, RECTIFIERS, TRANSISTORS, AND THE "OTHER" GROUPING SEMICONDUCTOR PRODUCTS DO NOT CAUSE THE JUMP IN THE SEMICONDUCTOR DEFLATOR



Source: BLS; MGI analysis

Exhibit 8

MOST OF MGI SEMICONDUCTOR PRODUCTIVITY JUMP LIKELY RESULTS FROM JUMP IN MICROPROCESSORS DEFLATOR



Source: BLS; MGI analysis

Exhibit 9

CAUSALITY SUMMARY EXPLAINS FOR SEMICONDUCTOR INDUSTRY PRODUCTIVITY GROWTH JUMP

Important (>50% of acceleration)

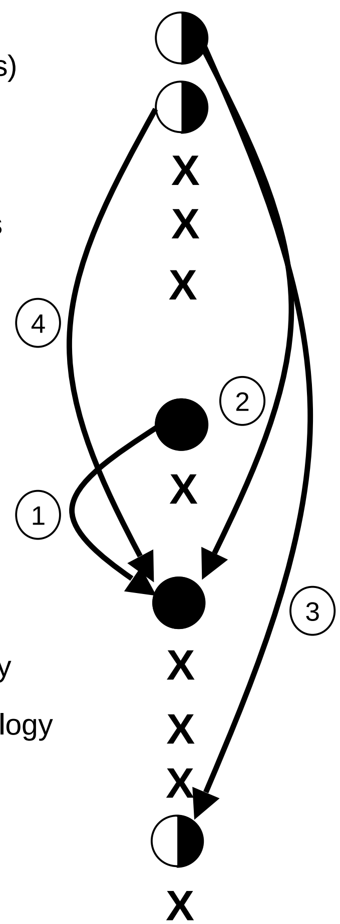
Somewhat important (10-50% of acceleration)

Not important (<10% of acceleration: asterisk to right indicates significant negative)

External factors
- Demand factors (macro-economic/financial markets)
- Technology/innovation
- Product market regulation
- Up-/downstream industries
- Measurement issues

Industry dynamics
- Competitive intensity
- Prices/demand effects

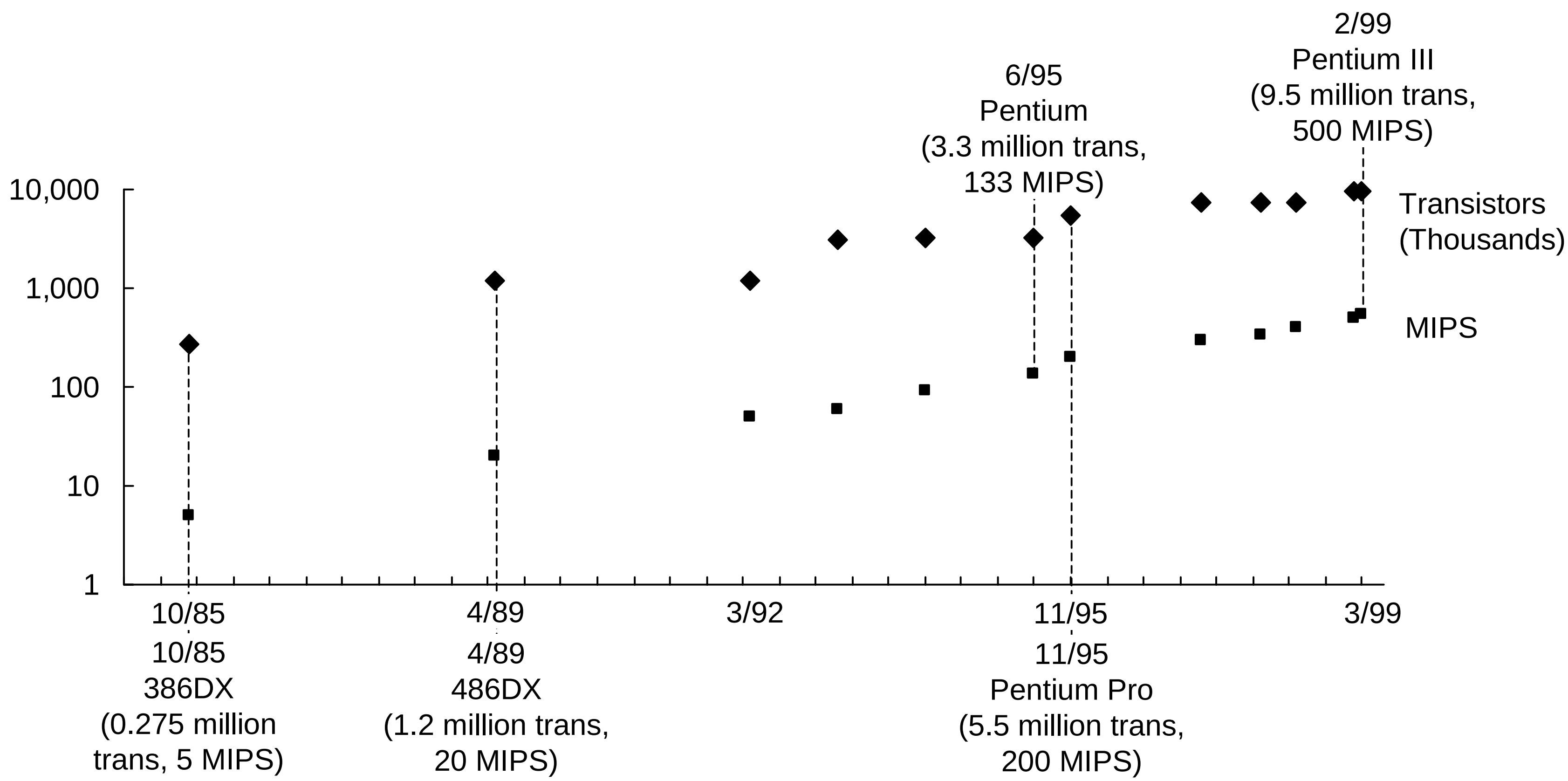
Firm-level factors
- Output mix
- Capital/technology/capacity
- Intermediate inputs/technology
- Labor skills
- Labor economies of scale
- OFT/process design



1. A surge in competitive intensity from AMD pushed Intel to more frequently release new chips such that, at any given time, Intel had the highest-performing chip on the market
2. High absolute levels of demand (in part from increased penetration) as well as demand specifically for high-performing chips (in part from upgrading behavior) shifted the output mix toward the “cutting edge”
3. High demand allowed microprocessor manufacturers to amortize R&D and other fixed labor costs more quickly
4. Technological improvements in both the semiconductor manufacturing equipment and in the wafer inspection/yield management industries shortened the time to profitable production yields and facilitated firms’ decisions to shorten the product life cycle (or to release new products more frequently)

Exhibit 10

DIFFICULT TO DETERMINE SIGNIFICANT CHANGES IN RATE OF PERFORMANCE GROWTH OF CUTTING EDGE CHIPS



	First period	CAGR Percent	Second period	CAGR Percent	Delta Percent
Growth in transistors/chip	10/85-6/95	29	6/95-2/99	33	4
	10/85-11/95	35	11/95-2/99	18	-17

- As technology improves in steps, unclear if performance is accelerating (evidenced by both positive **and** negative delta calculations)
- Not clear that this results in negative acceleration of deflator from 1995-99

Source: Intel; MGI analysis

Exhibit 11

ILLUSTRATIVE

A MORE CURRENT BASKET OF CHIPS CAUSED AN ACCELERATION TOWARD THE TECHNOLOGY FRONTIER

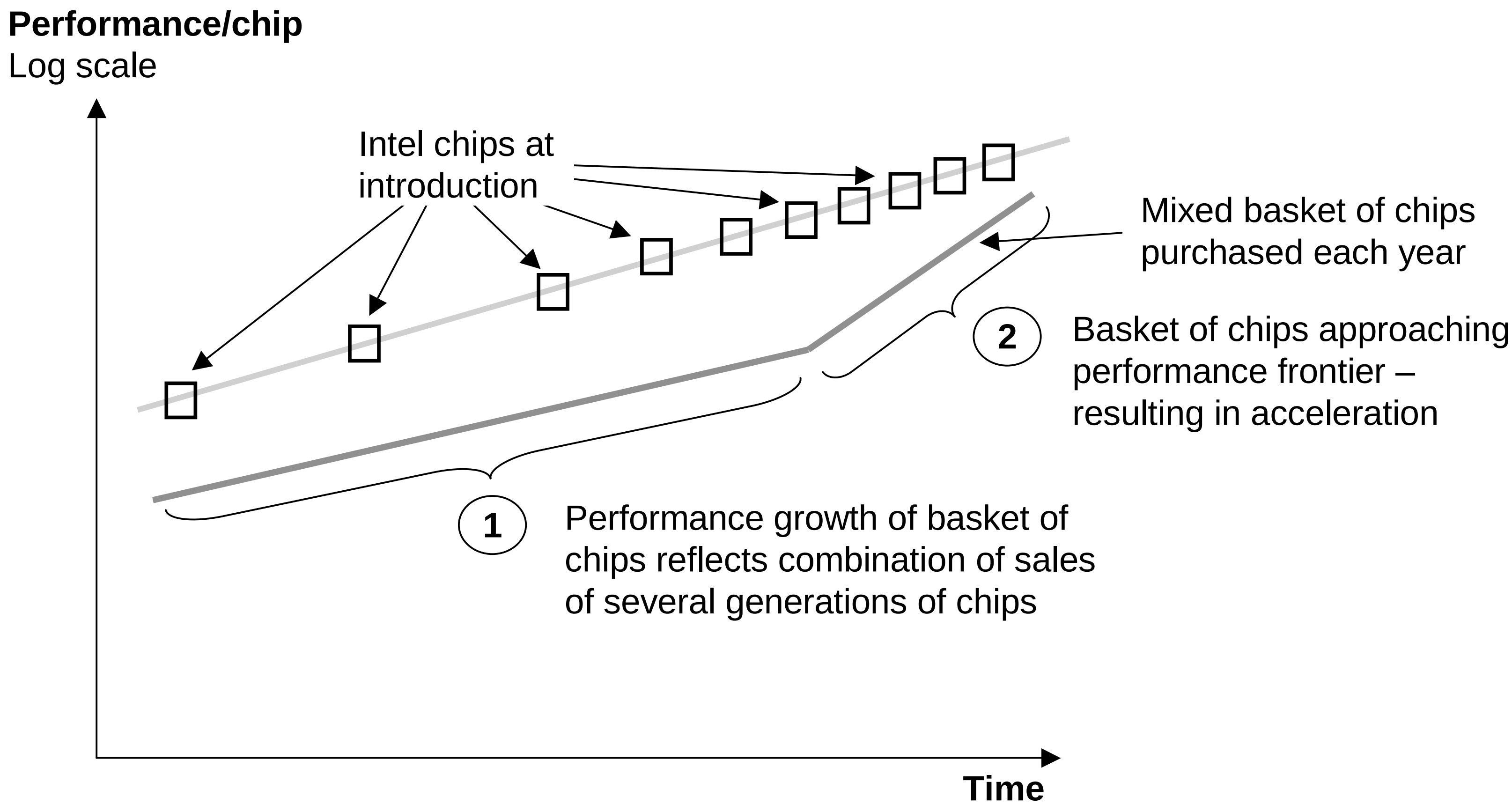
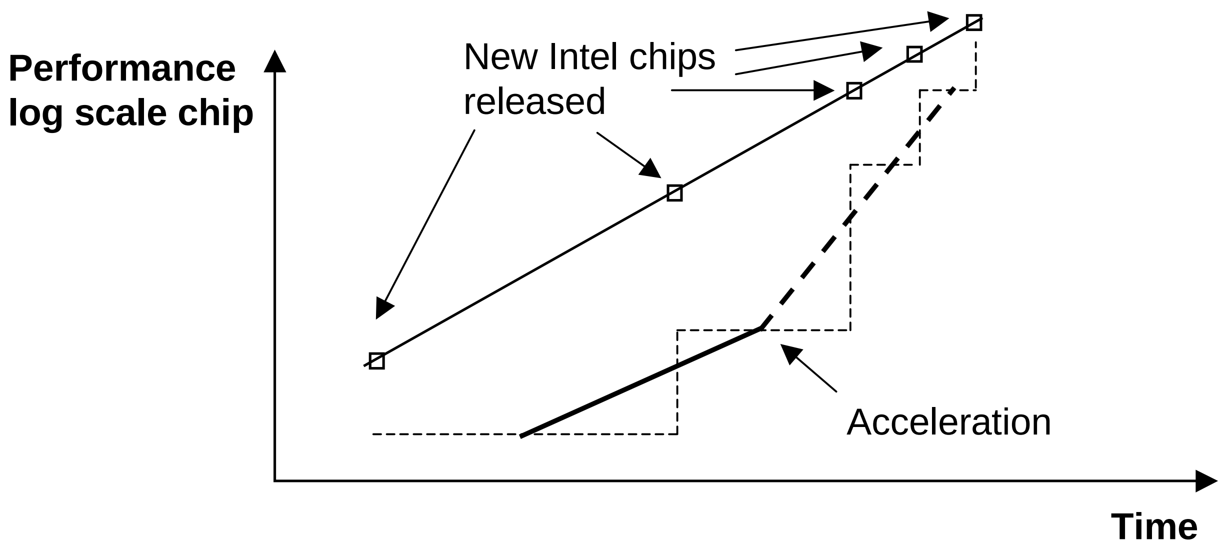


Exhibit 12

ILLUSTRATIVE

INCREASED FREQUENCY OF CHIP RELEASE CAN LEAD TO PERFORMANCE ACCELERATIONS IN SEVERAL WAYS

1. The basket of chips contains similar proportions of cutting-edge, 2nd-, and 3rd- generation – but the 2nd and 3rd generation chips are relatively "newer"



2. The basket of chips contains greater proportions of cutting-edge chips, prompted by people wanting to stay closer to the cutting edge

Old basket		New basket	
	50% = 386		30% = Pentium
	50% = 486		70% = Pentium Pro

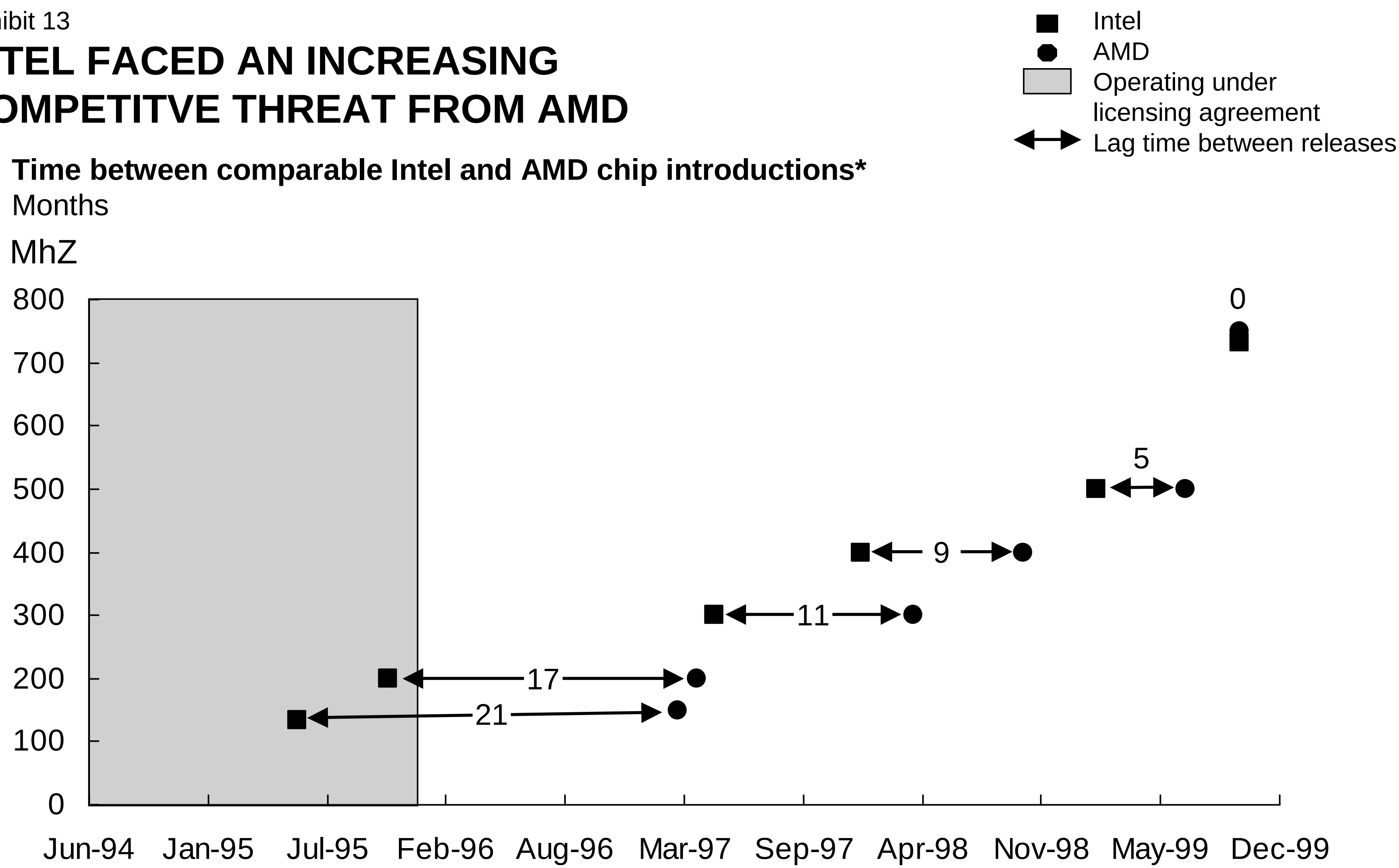
3. Combination of the above

Exhibit 13

INTEL FACED AN INCREASING COMPETITVE THREAT FROM AMD

Time between comparable Intel and AMD chip introductions*

Months



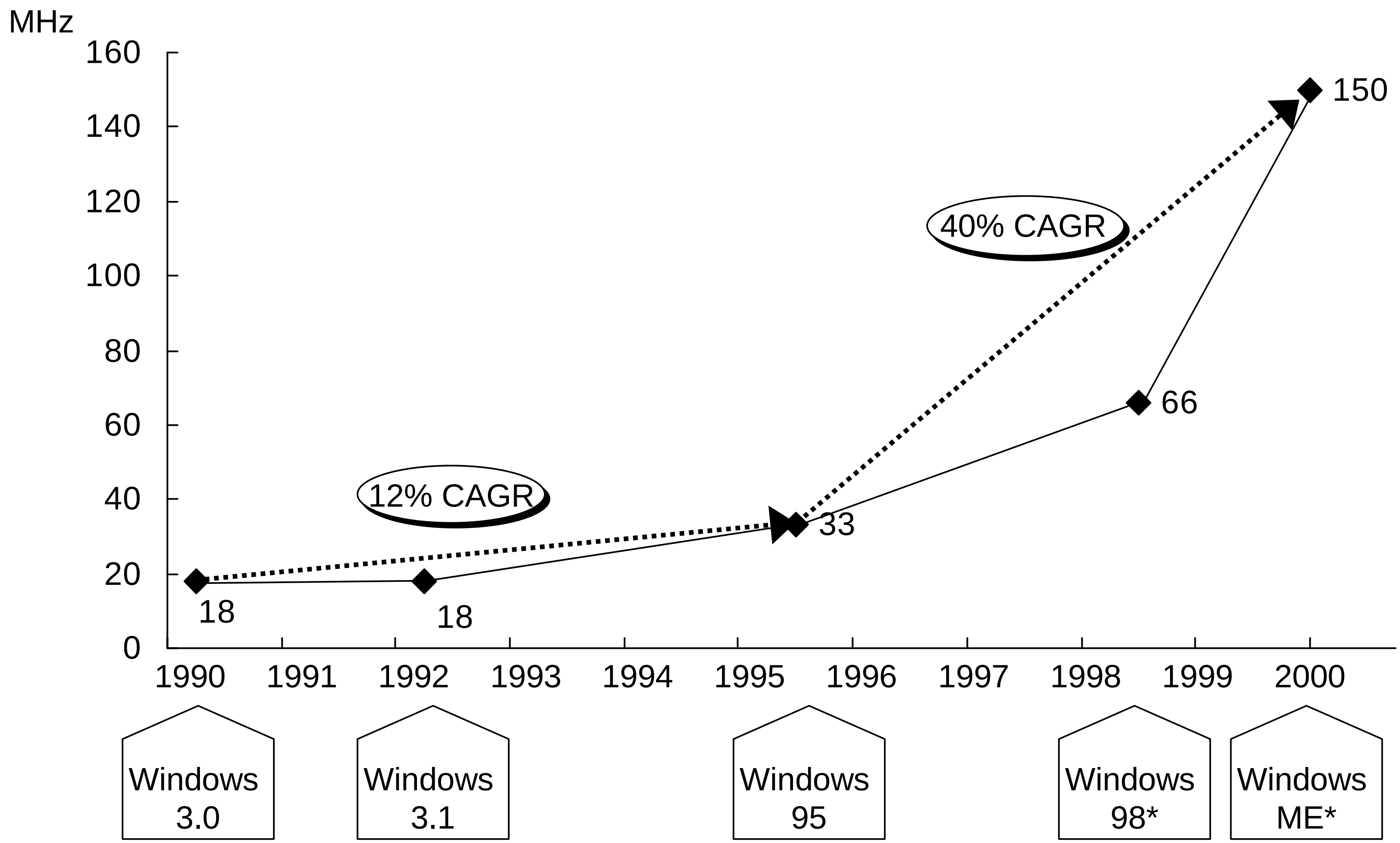
* Only includes releases most suitable to comparison, both companies released many more chips over the period

Source: Intel; Dataquest; Macinfo.de; MGI analysis

Exhibit 14

OPERATING SYSTEMS' PERFORMANCE REQUIREMENTS HAVE ACCELERATED

Processor speed requirement



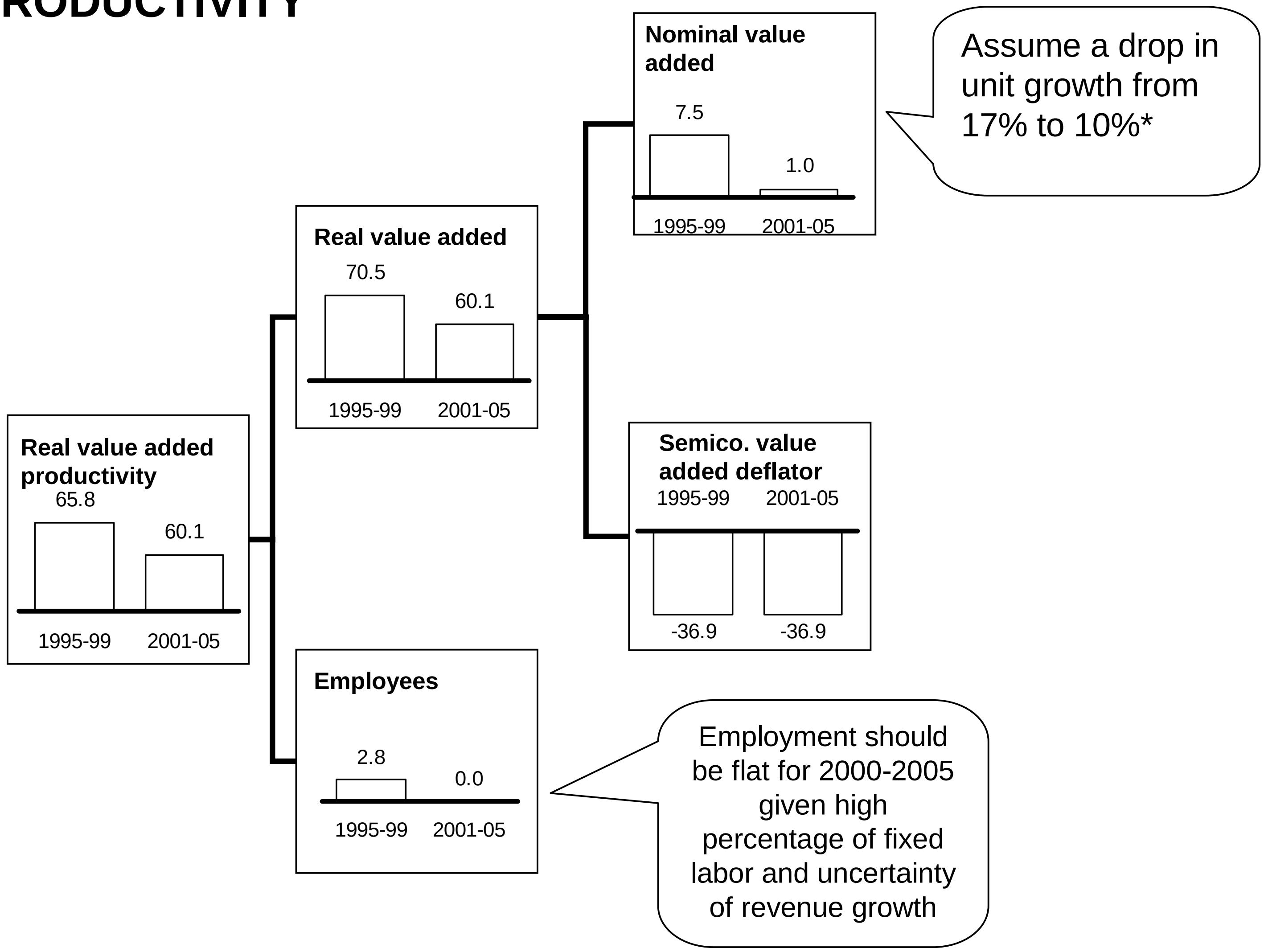
* Second edition

Source: Microsoft; Datapro; McKinsey analysis

Exhibit 15

SUSTAINABILITY OF SEMICONDUCTOR INDUSTRY VALUE ADDED PRODUCTIVITY

CAGR

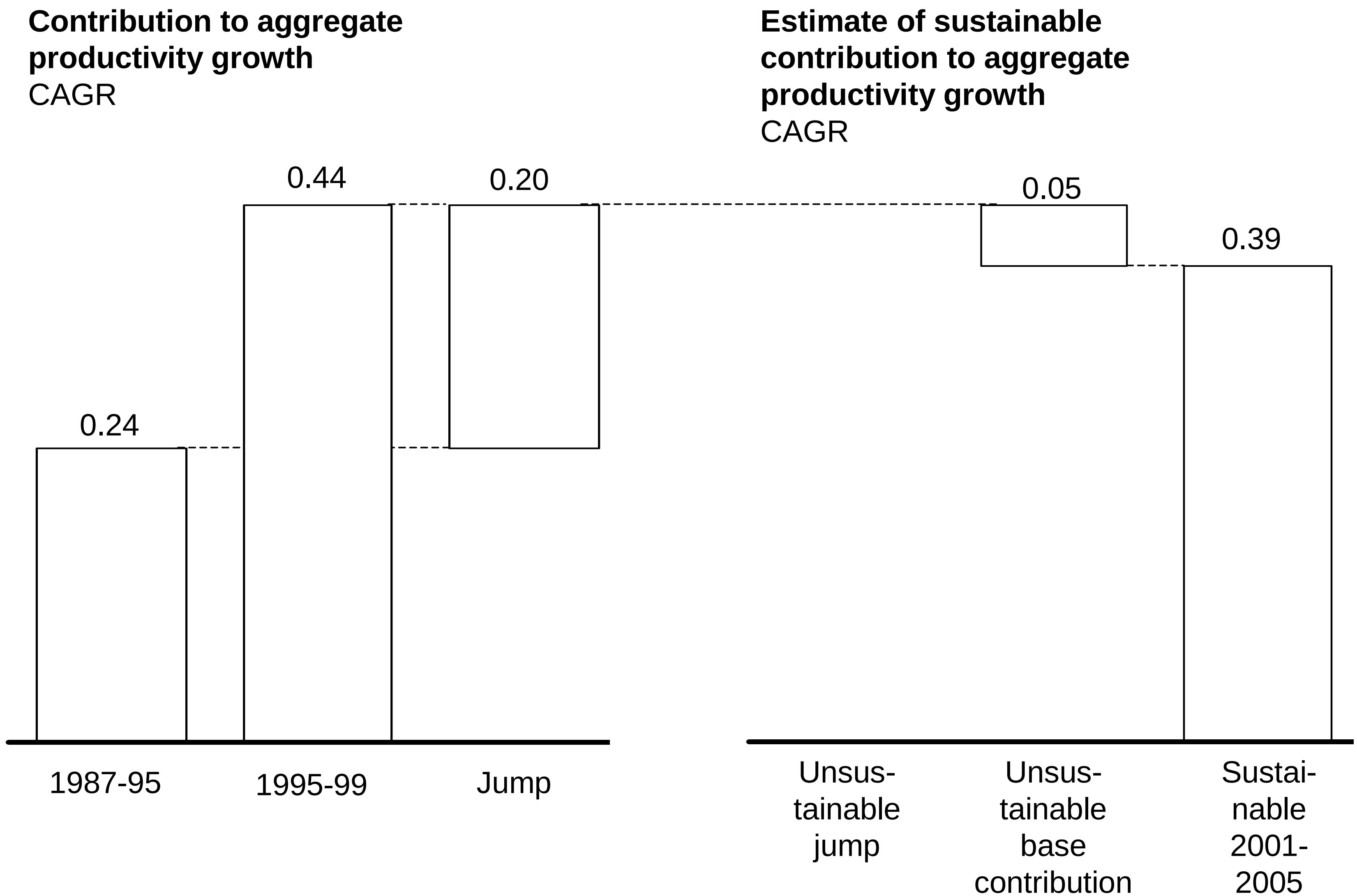


* We assume that nominal growth of value added per unit stays fixed, while total units demanded decrease from 17% to 10%

Source:BLS; IDC; Census of Manufacturing; NBER; Double deflated Fischer indexed; McKinsey analysis

Exhibit 16

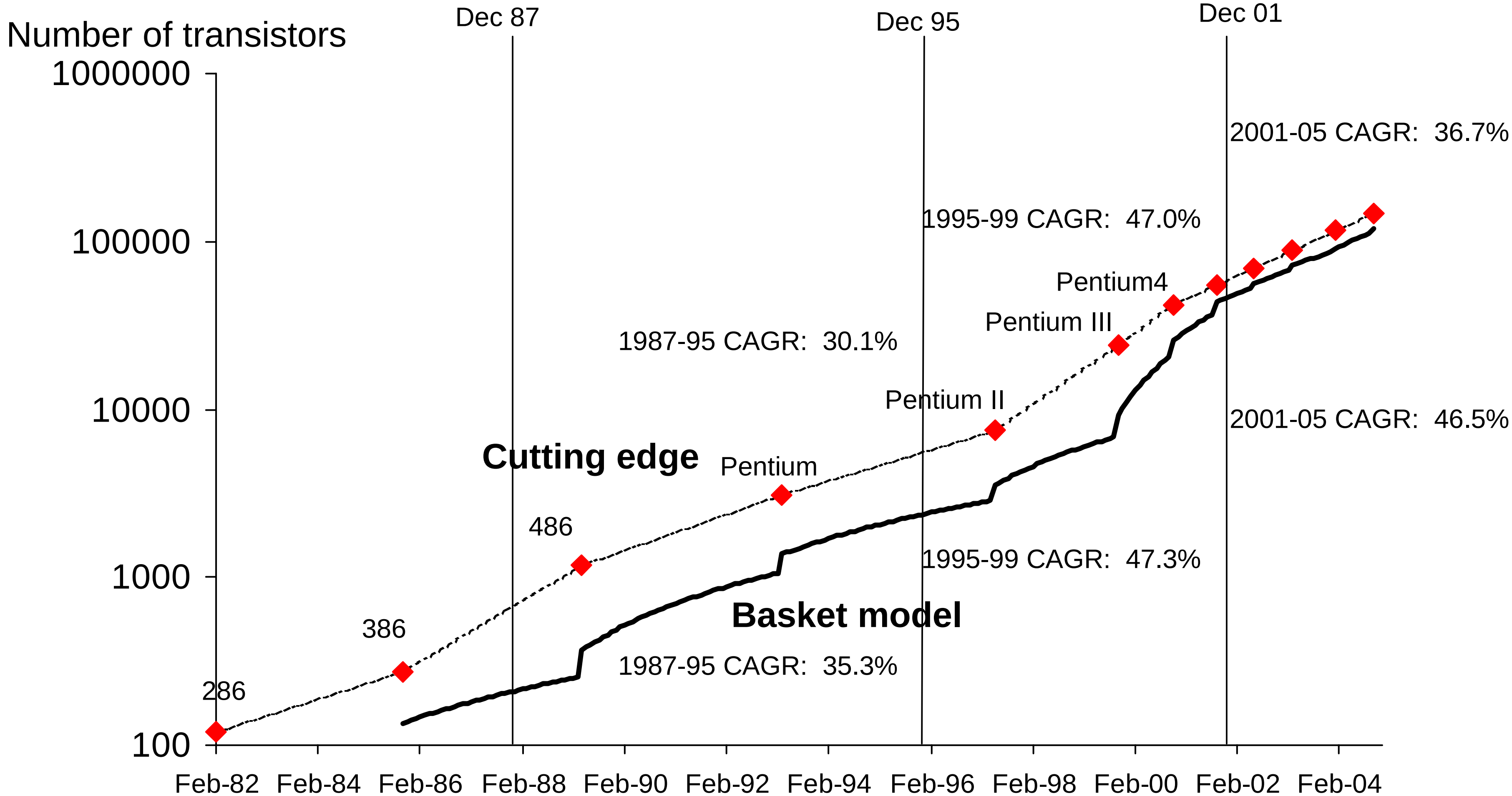
SUSTAINABILITY OF CONTRIBUTION OF SEMICONDUCTOR MANUFACTURING SECTOR TO AGGREGATE PRODUCTIVITY GROWTH



Source: McKinsey analysis

Exhibit 17

THE GROWTH IN THE PERFORMANCE OF THE BASKET OF MICROPROCESSORS SHOULD BE SUSTAINABLE*

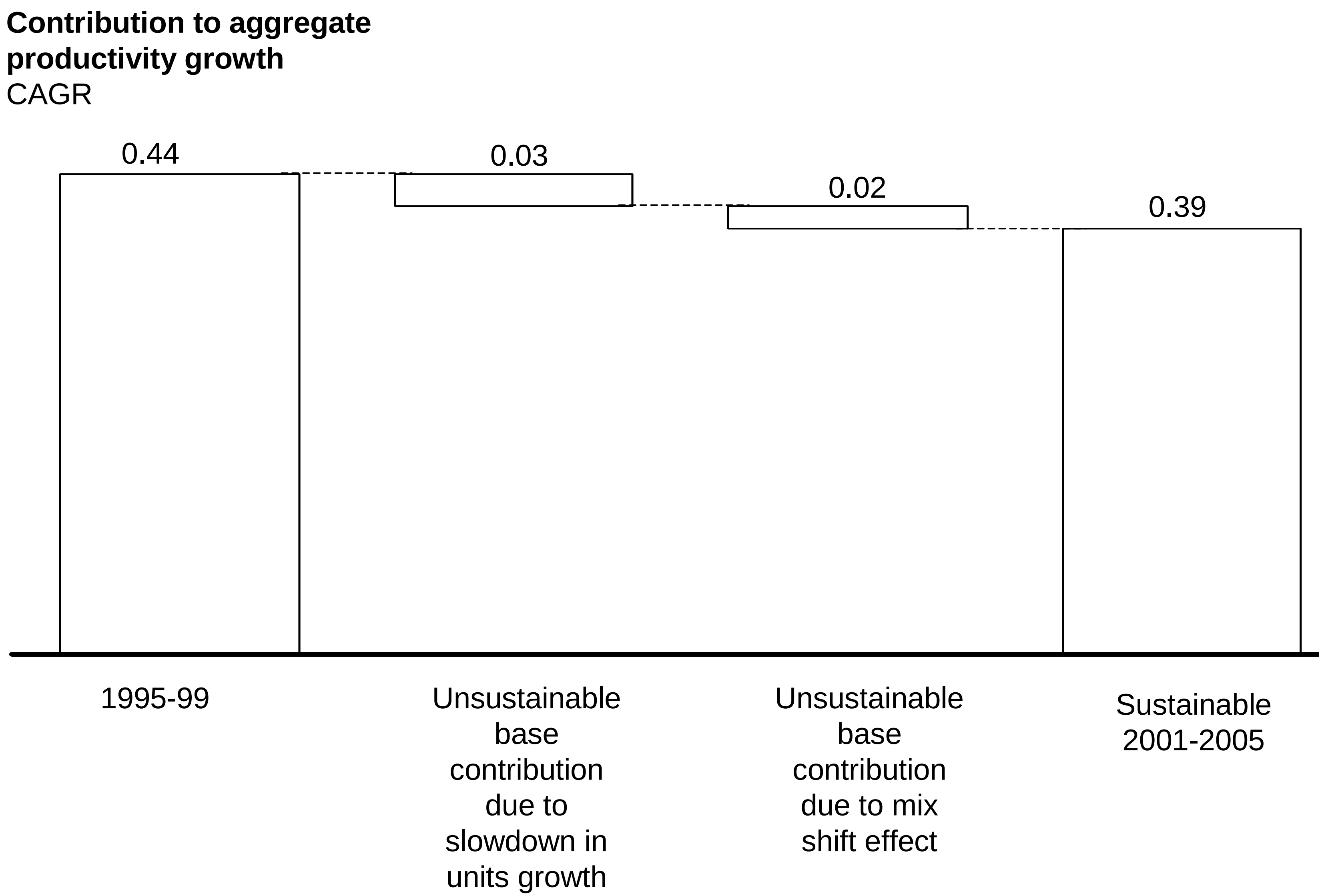


* Assuming number of transistors per chip grows at the historical 36.7% rate after Pentium 4 and the release cycle for cutting edge microprocessor remains at 9 months through the end of 2004. This model also assumes that at any given time the basket consists of two generations of microprocessor and that penetration rate of the new microprocessor starts out at 10% and increases linearly to 90% when the next generation is released and then falls linearly to 10% when the subsequent generation is release.

Source: McKinsey analysis

Exhibit 18

SUSTAINABILITY OF CONTRIBUTION OF SEMICONDUCTOR MANUFACTURING SECTOR TO AGGREGATE PRODUCTIVITY GROWTH



Source: McKinsey analysis

Computer manufacturing

SUMMARY

While computer manufacturing only contributes 0.07 percent to total US employment and only 0.77 percent to total US GDP, it has contributed a fairly significant 7.5 percent (0.10 out of 1.33 percentage point) to the aggregate productivity growth acceleration.

In the computer manufacturing sector, the acceleration since 1995 in the capability of the computer has caused 90 percent of the acceleration in measured productivity growth based on real value-added. US government output statistics, through the use of the computer price deflator, capture the improvements in the performance of computers, which are mainly attributable to technological advances in the intermediate inputs (e.g., microprocessors, memory, storage devices, CD-ROM/DVDs and communication components).

An alternative productivity measure based on units per employee, which is not affected by the improvement in the performance of computers, is showing very high growth rates, but has only slightly accelerated. Hardware integrations (reduction in number of components and standardization of components) account for most of the high- growth levels in unit productivity.

The sustainability of real value-added based productivity growth rates depends on the sustainability of the high rate of growth in computer capability. This will be determined by a number of factors:

- The continuation into the future of quality and technological improvements in intermediate inputs
- Intense competition in the input markets
- The nature of demand driven by the willingness of computer buyers to move to the next generations of standard operating systems and software, which are much more demanding of computing power
- The propensity of buyers to purchase more units if prices fall.

The sustainability of unit productivity will be determined by the continuation into the future of technological innovations, which will allow for further hardware integrations, outsourcing to contract manufacturers, and the ability of computer manufacturers to rapidly adjust labor in line with demand for units.

MGI believes that computer manufacturing productivity growth exhibited from 1995-99 will not be maintained through 2005. For 2001-05, growth rate of the performance of computers will be maintained, but softening domestic unit demand for computers will drive down this sector's productivity growth. In the future, high levels of penetration and the lengthening of the replacement cycle will mean significantly lower unit growth for this sector.

Computer manufacturing

OVERVIEW OF COMPUTER MANUFACTURING INDUSTRY

Most of the acceleration in real productivity growth in computer manufacturing since 1995 can be attributed to technological improvements in input industries rather than to direct actions taken by computer manufacturers themselves. The real productivity gains, as measured in government statistics, reflect increases in computer capabilities directly attributable to performance improvements in intermediate inputs. Computer manufacturers have merely passed on the higher value inputs but are attributed a lion's share of the real productivity gains.

At the physical level, computer manufacturers have enjoyed an unheard of 20 percent rate of growth in units per employee productivity for over a decade. They have worked closely with their component manufacturers and suppliers to reduce the number of components and to form standards to simplify computer architecture, which enable more efficient manufacturing processes. However, there has not been a significant acceleration in the already high unit-based productivity growth rate since 1995.

Industry profile

Computer manufacturing (as defined by SIC 3571) represents 0.07 percent of private sector employment and 0.77 percent of total value added (GDP) in the US economy (Exhibit 1).

This industry includes the manufacturing of personal computers (both desktops and portables), servers, and mainframes. In 1998, desktop PCs accounted for 60.1 percent of the revenues, portable PCs 19.2 percent, and servers and mainframes 20.7 percent (Exhibit 2).

In 1999, the top five US computer manufacturers in order of market share were Dell (17.1 percent), Compaq (15.3 percent), Gateway (9.3 percent), Hewlett-Packard (8.2 percent), and IBM (7.6 percent). Throughout both periods, this industry has been competitive with dynamic changes in market share among players. For example, Dell's market share increased from 4.9 percent in 1995 to 17.1 percent in 1999, while Apple's market share dropped from 10.6 percent to only 4.6 percent. At the same time, Packard Bell, which in 1995 had 14.4 percent market share, has since dropped out of this industry.

Computer manufacturing process can be broken up into research and development, manufacturing and assembly, distribution and configuration, and sales and marketing (Exhibit 3).

- ¶ Computer manufacturers' R&D departments define and engineer the design of the computer taking into consideration the demand for computer performance/capability and the price-to-performance characteristics of intermediate inputs.
- ¶ The manufacturing department first assembles small analog and digital components onto the motherboard and then places it, along with other major components, into an enclosure.
- ¶ The distribution department then stores and transports the computer to the computer wholesaler/retailer. Computers may undergo further configuration such as addition of software and more memory once they have left the factory floor.
- ¶ The marketing and sales department generates demand through advertising and customer management as well as executing the orders taken from the customers.

Importance of computer manufacturing industry to the overall question

Computer manufacturing contributed 0.10 percentage point to the overall US productivity growth jump of 1.33 percent, accounting for 7.5 percent of the aggregate productivity jump (Exhibit 1). It explains almost 83 percent of the jump in the industrial machinery and equipment sector, which has the fifth largest contribution of any sector to the aggregate productivity growth jump (Exhibit 4).

- ¶ The main contribution of computer manufacturing to the aggregate US productivity growth jump (as measured with Bureau of Economic Analysis, BEA data) came from within-sector productivity growth rather than from shifts in employment share between sectors (0.14 percent due to within-sector growth and -0.04 percent due to decrease in employment share in this highly productive industry).
- ¶ Over the time period examined by MGI, computer manufacturing increased its labor productivity growth rates by 33 percentage points (from 27 percent to 60 percent per year, 1987-95 versus 1995-98).

At the four-digit SIC level, IT capital stock data is not available for computer manufacturing. However, the industrial machinery and equipment sector, which does include computer manufacturing, did experience a substantial acceleration in its IT capital intensity growth rate in real terms (a 15 percentage point increase in annual growth rates from 7 percent to 22 percent per year, 1987-95 versus 1995-

99), reflecting in part the increased capability and quality that a given dollar of IT spending represents (Exhibit 5).

LABOR PRODUCTIVITY PERFORMANCE

Using the sources and methodology described below, MGI calculated that for the computer manufacturing industry:

- ¶ Real value-added based labor productivity growth rate rose from 27 percent in 1987-95 to approximately 60 percent from 1995-98 (Exhibit 6).
- ¶ Unit-based labor productivity growth rose from 18 percent in 1987-95 to approximately 21 percent from 1995-98 (Exhibit 6).

The BEA's calculated real GDP contribution for computers reflects a hedonic adjustment for quality improvements in the industry's output. BEA uses the computer output deflator estimated by the Bureau of Labor Statistics, BLS using a hedonic regression that takes into account changes in the microprocessor speed, memory size, hard disk size, video memory size, audio capabilities, modem/networking capabilities, warranty, and other characteristics. The BLS methodology reflects the latest research in this area by both academic and government economists, and there was not a change or break in their methodology between the two periods.

The BEA does not explicitly break out a GDP contribution for the computer manufacturing industry – only for the broader industrial machinery and equipment industry. Consequently, MGI constructed its own productivity measurement data for computer manufacturing from the National Bureau of Economic Research (NBER), which provided data from 1987 to 1996.

Four-digit SIC level nominal data from the Census and BLS price deflators for computer output and intermediate inputs were used to extend the NBER series to 1998. While the absence of data prevented extension to 1999, this was not an unusual year in computer manufacturing. Thus, the conclusions made from the analysis up to 1998 should also hold for 1999.

MGI uses two complementary measures of labor productivity based on real value added and units.

- ¶ The real value-added based productivity employs the same approach as in the other sectors covered by MGI using the BEA industry-level data. It is defined as real value-added per employee. Conceptually, value-added is the sum of the compensations to workers and to owners of capital or the difference between gross output and intermediate inputs.

¶ The unit-based productivity is a physical measure of productivity and is defined as units manufactured per employee (see appendix for details). The unit measure for computer manufacturing is a Fisher aggregation of units of desktop PCs, portable PCs, and servers (including mainframes).

MGI real value-added based analysis is generally consistent with the BLS results (Exhibit 7). Though BLS uses real gross output instead of value added, the orders of magnitude and the direction of the growth rates are in alignment. MGI uses value-added to be consistent with GDP aggregation using double-deflation of output and input. There are some inconsistency in the way the input and output deflators are calculated. Not all of the inputs are hedonically adjusted. As a result, the value added deflator captures all of the residual differences between the hedonically adjusted output deflator and the semi-hedonically adjusted input deflator.

EXPLAINING THE JUMP IN 1995-98 LABOR PRODUCTIVITY GROWTH

Disaggregating the drivers of computer manufacturing productivity makes clear that the real value-added based productivity jump was caused mainly by the changes in computer performance as captured by the output deflator (Exhibit 6). Approximately 90 percent of the value-added based productivity resulted from changes in real value added per unit rather than changes in units per employee.

The hedonically adjusted computer output deflator captures improvements in computer performance. The deflator then causes real value added per employee to similarly reflect performance improvements. Therefore, explaining the industry's productivity acceleration requires explaining the causal factors that led to the negative growth in the computer output deflator from -1.4 percent to -31.9 percent per year, 1987-95 versus 1995-98 (Exhibit 6).

Firm-level (operational) factors

At the firm level, accelerating technological improvements in intermediate inputs have enabled computer manufacturers to shift their output mix toward more powerful computers (Exhibit 8). Technological improvements in intermediate inputs have accelerated. In particular, there have been tremendous technological improvements in price-to-performance of microprocessors, hard disks, CD-ROM/DVD players, modems, network cards, and other inputs to the computer manufacturing industry. To meet the increase in demand for more powerful computers, computer manufacturers have shifted their output for each platform to more powerful units. The relative revenue share of each platform has not changed

(Exhibit 2), but within platforms there have been shifts to more powerful computers.

IT-enabled drivers did not play a major role in the productivity growth jump and were only minor contributors to the high unit productivity growth level in both periods. In the earlier period, electronic data interchange (EDI) was being used to automate the supply chain. This system replaced the traditional paper, phone and fax system used to place orders between OEMs and component suppliers and manufacturers. The benefits from these systems may have resulted in a one-time increase in unit productivity of around 10 percent, which is slightly over half of the unit productivity growth in a single year. EDI's contribution was a one-time step function rather than a continuous function.

In the latter period, EDI was gradually replaced by Internet-based EDI and other electronic supply chain management (eSCM) systems. Though the new systems did not bring about substantially greater capability, they did provide access to more of the smaller players that could not afford the expensive EDI systems in the earlier period. EDI may have facilitated an easier transition to the use of contract manufacturers by OEMS but was not a prerequisite. Even today, much of the ordering between OEMs, CMs, and component suppliers and manufacturers is done by phone and fax.

Some computer manufacturers have improved the management of their supply chain by shifting the burden and responsibility to their suppliers. It is now up to the supplier to maintain a stock of components accessible at all times to the computer manufacturers.

Built-to-order (BTO) and custom interface automation have not been fully implemented even by top manufacturers, which sell a majority of their computers in the standard configuration. An order for a nonstandard configuration takes longer to fill, since it will have to be custom built, while standard configurations are typically ready for quick shipment.

External factors

In the last 5 years, there has been a spiraling feedback loop between economic growth and IT investment. As the economy grew, IT investment and demand for computers grew, which in turn led to further economic growth and so on. Greater demand for computers, along with technological innovations in the use of computers, performance improvements in intermediate inputs, and an increase in competitive intensity in the input markets allowed computer manufacturers to shift to the production of computers with ever higher capability.

Demand

There has been unprecedented demand for computers in the last 5 years. Businesses have made large investments in IT as their IT budgets were tied to their revenue growth. As the economy blossomed, IT budgets became bloated. The hype and promise of the "new economy" were taken very seriously by businesses, and they rushed to invest in IT systems to maintain their competitive edge. (See below, ***Projections of future unit demand growth***.)

Technological innovations

More powerful standard operating systems and application software have increased the demand for computers with higher performance capabilities. As an example, the growth rates for microprocessor speed and minimum memory requirements for each generation of Microsoft operating system have accelerated (Exhibit 9). Microprocessor speed requirements have grown from 10.5 percent per year for 1990-95 to 38.1 percent per year for 1995-2000. Minimum memory requirements have grown from 14.9 percent per year for 1990-95 to 51.6 percent per year for 1995-2000.

The rapid growth of the Internet and the compounding of network effects (computers become more valuable as more computers are networked) have contributed to the increase in demand for more capable computers. Fast and reliable connectivity to the Internet/intranet has required computers with more advanced modems and other networking devices, faster microprocessors, and more standard and video memory.

Performance improvements in intermediate inputs

Technological innovations in the intermediate input industries have led to more powerful and cheaper intermediate inputs. Existing components such as hard disks and memory have experienced great accelerations in performance-to-price ratios. New features such as CD-ROM/DVD players, high-speed modems, and network cards, which either were not available or had very low penetration due to high costs, are now standard features.

Competition in the upstream industries

The struggle for market share between Intel and AMD has resulted in an increase in the pace of innovation in the microprocessor market. Microprocessor manufacturers have been forced to roll out "cutting edge" microprocessors more quickly, and the basket of microprocessors sold has shifted towards the "cutting edge" microprocessors. (See semiconductor case.) Simultaneously, increase in the intensity of competition in the DRAM market has led to a rapid decline in the price of memory. This has led to more memory being offered on all computer platforms at an accelerating rate.

OUTLOOK, 2001-05

MGI believes that computer manufacturing productivity growth exhibited from 1995-99 will not be maintained through 2005. For 2001-05, the growth rate of the performance of computers will be maintained, but softening domestic unit demand for computers will drive down this sector's productivity growth. In the future, high levels of penetration and the lengthening of the replacement cycle will mean very low unit growth rate for this sector.

The sustainability of real value-added based productivity depends on the combination of the sustainability of computer performance as captured in the computer output deflator and unit-based productivity growth.

Sustainability of computer performance growth

Future computer performance to price improvements will be captured in U.S. government data through changes in the computer output deflator. Although the rate of computer output deflator decline decreased in 1999-2000, it picked up again at the end of 2000 (Exhibit 10) as a PC inventory glut is causing price wars among computer manufacturers. The stream of innovation and input performance improvement look sustainable into the immediate future. Barriers to the continuation of Moore's Law at least at its historic rate should be overcome given the competitive incentives do so, and product life cycles for cutting edge chips are unlikely to lengthen. Intel’s public statements about future chip releases through 2002 and potential transistors per chip in 2007 suggest that the industry may be able to do even better than these base assumption. By 2003, Intel is likely to have moved to 0.13 micron technology and a 3,000 MHz clock speed. Extreme Ultraviolet Lithography (EUV) technology, just recently prototyped, will drive Moore's law and push etching down to 0.01 microns (versus 0.18 microns today). (See semiconductor case.)

Drivers of past unit-based productivity

The major driver for unit-based productivity growth in the previous two periods was architectural simplification (Exhibit 11). With the exception of outsourcing to Asian contract manufacturers, the other drivers played only a minor role. From the beginning, the design and manufacturing of computers have undergone a continual process of simplification and standardization. More and more analog and digital components have been integrated into to fewer standardized semiconductor components. With each new generation of computers, the numbers of semiconductor chips have decreased (Exhibit 12). Fewer standard components mean that it takes less time and fewer employees to assemble more units of computers.

Over both periods, computer OEMs have been shifting lower value-added and more volatile manufacturing activities to contract manufacturers (CMs). Retaining the higher value-added activities and producing more units while reducing the number of manufacturing workers has meant higher productivity growth rates for the OEMs. CMs were able to specialize and consolidate manufacturing capital within the industry. Taking advantage of both lower cost labor and greater capital/labor utilization, CMs were able to manufacture at lower costs and higher productivity than the OEMs. Since the computer manufacturing industry includes both OEMs and CMs, outsourcing of manufacturing has meant higher rates of productivity growth for the industry as a whole. The role of CMs has moved from simpler manufacturing tasks (e.g., motherboard assembly) to more complicated processes (e.g., product engineering) over time. However, the use of CMs has been increasing at a linear rate. In the earlier period, manufacturing was outsourced to North American CMs, but in the latter period more of the manufacturing has been outsourced to Asian CMs. Due to size and design, a larger share of portable computers are manufactured by CMs than desktops or servers (Exhibit 13). Overall, outsourcing of low productivity functions overseas mean higher productivity for remaining domestic part of the industry.

Economies of scale played only a minor role. The optimal scale for computer manufacturing had already been reached in the earlier period. By serving many different OEMs simultaneously to optimize capital utilization, any scale effects that took place in this industry in the latter period, were with the CMs.

Changes in the manufacturing process were minor drivers of productivity growth. Throughout both periods, new capital was invested to automate the manufacturing process, especially in the manufacture of motherboards. At the same time, the organization of the final assembly workers moved toward the "cell-based" system, where a small team of workers put together all of the major components into the computer enclosure.

Drivers of future unit-based productivity

The major driver, integration of computer hardware and reduction in the number of components, will continue into the near future. All major semiconductor elements could be integrated onto one chip, the microprocessor, as it takes on additional functionality. Many elements of analog functionality such as audio, modems, and networking could be integrated via soft technology.

Other minor drivers, including outsourcing to Asian CMs, will also play a role into the near future. Electronic SCM systems will continue to network more component suppliers/manufacturers, CMs, OEMs, and computer distributors/retailers.

Projections of future unit demand growth

By 2000, business PC penetration (measured as the total number of units of PCs deployed versus the total number of employees) stood at 56 percent after increasing at a rate of almost seven percentage points per year during the late-1990s. Business PC penetration is quickly approaching its upper threshold of ~70 percent (Exhibit 14). Household penetration (measured as the total number of household PCs deployed versus total number of households) stands at 51 percent and will likely follow adoption patterns for VCRs and telephones, eventually approaching ~90 percent (Exhibit 15).

Sixty-five million out of the 208 million cumulative PC units purchased between 1995 and 2000 were due to extraordinary factors (Y2K, the emergence of the Internet, the initial buildup of corporate networking infrastructure, and rapid PC upgrade cycles) that led to higher penetration and a shortening of replacement cycles (Exhibit 16). It is, therefore, highly unlikely that computer units growth in the next period will be near the 1995-98 growth rate of 17 percent per year.

Using the historical trajectory of computer penetration and the likely trajectory of future penetration, we can project a unit growth for this industry. Assuming a replacement cycle of 4 years prior to 1995, 3 years between 1995 and 2000, and back to 4 years after 2000, we estimate an annual unit growth of 3 percent for 2001-05 (Exhibit 17).

Sustainability of value-added based productivity

Assuming the 3 percent annual rate of growth in unit demand from 2001-05 and the continuation of the 1995-98 rate of growth for the computer value-added deflator, we can estimate the sustainability of real value-added productivity and this sector's contribution to the aggregate productivity growth. Computer manufacturers are likely able to reduce both fixed and variable workers by an additional 5 percentage points per year through consolidation of manufacturing and headquarter functions. This will mean that employment growth will drop from the 1995-98 annual rate of negative 3 percent to negative 8 percent for 2001-05. As a result, unit productivity growth rate will decline to 12 percent and the value-added productivity growth will drop to 48 percent (Exhibit 18).The computer manufacturing sector contributed 0.10 percentage points to the aggregate productivity growth jump through an increase in value-added productivity from 27 percent for 1987-95 to 60 percent for 1995-99. The period contributions to the aggregate productivity growth rate for this sector were 0.10 percentage points for 1987-95 and 0.20 percentage points for 1995-99 (Exhibit 19).

All of the 0.10 percentage point contribution to the jump will be sustainable, but the 0.07 out of the 0.10 percentage point base productivity contribution for 1987-95 will not be sustainable, resulting in a 2001-05 sustainable contribution of 0.13 percentage points.

Alternatively, we can attribute the projected drop in the 0.20 percentage point contribution to the 1995-99 aggregate productivity growth to two different factors (Exhibit 20):

- ¶ Unsustainable 1987-95 base contribution of 0.05 percentage points due to drop in unit growth to 3 percent annual growth.
- ¶ Unsustainable 1987-95 base contribution of 0.02 percentage points due to mixed-shift effects from additional reduction of labor in a highly productive sector.

Note that all of the contribution to the aggregate productivity growth jump of 0.10 percentage point is sustainable, since the performance growth of computers, the main driver of the jump, will continue to grow at its 1995-99 rate. This again results in a 2001-05 sustainable contribution to the aggregate productivity growth of 0.13 percentage points.

APPENDIX

Detail on unit-based productivity measurement

Historical unit shipment and revenue numbers for desktop PC, portable PCs, and servers (including mainframes) were available from Dataquest (Exhibit A1).

Using the BEA Fisher equation, an aggregated output measure is constructed taking into account both the unit shipments and revenue share of each platform.

Labor measures are from NBER (1987-96) and the Census (1997-98). They report both production and nonproduction workers separately (Exhibit A2). Nonproduction workers include those working in R&D, sales and marketing, administration, and other headquarter functions.

The hedonic deflator

A hedonic deflator is a gauge economists seek to use in order to quantify the functional capacity of certain goods whose performance or function changes over time (Exhibit A3). The use of hedonic deflators is most appropriate when there is a strong relationship between a good's performance and its price. This essentially allows economists some manner in which to separate out performance improvements, which alter the price, and hence, to determine how performance-adjusted prices are changing. Hedonic deflators are frequently used in high technology industries such as computers and semiconductors, as well as for goods such as automobiles or for types of health care.

The weights used to measure the performance characteristics result from hedonic regressions. These are essentially multiple regressions of price data with variables representing various characteristics of the good. For computers, such characteristics included microprocessor speed, memory size, hard disk size, video memory size, audio capabilities, modem/networking capabilities, and warranty. The regression essentially calibrates the value of each performance characteristic based on the historical price data. Once the value of each characteristic (or combination of characteristics) is determined, one can determine a good's performance-adjusted price.

CONFIDENTIAL

Computer Manufacturing Case Study

MGI/High Tech Practice

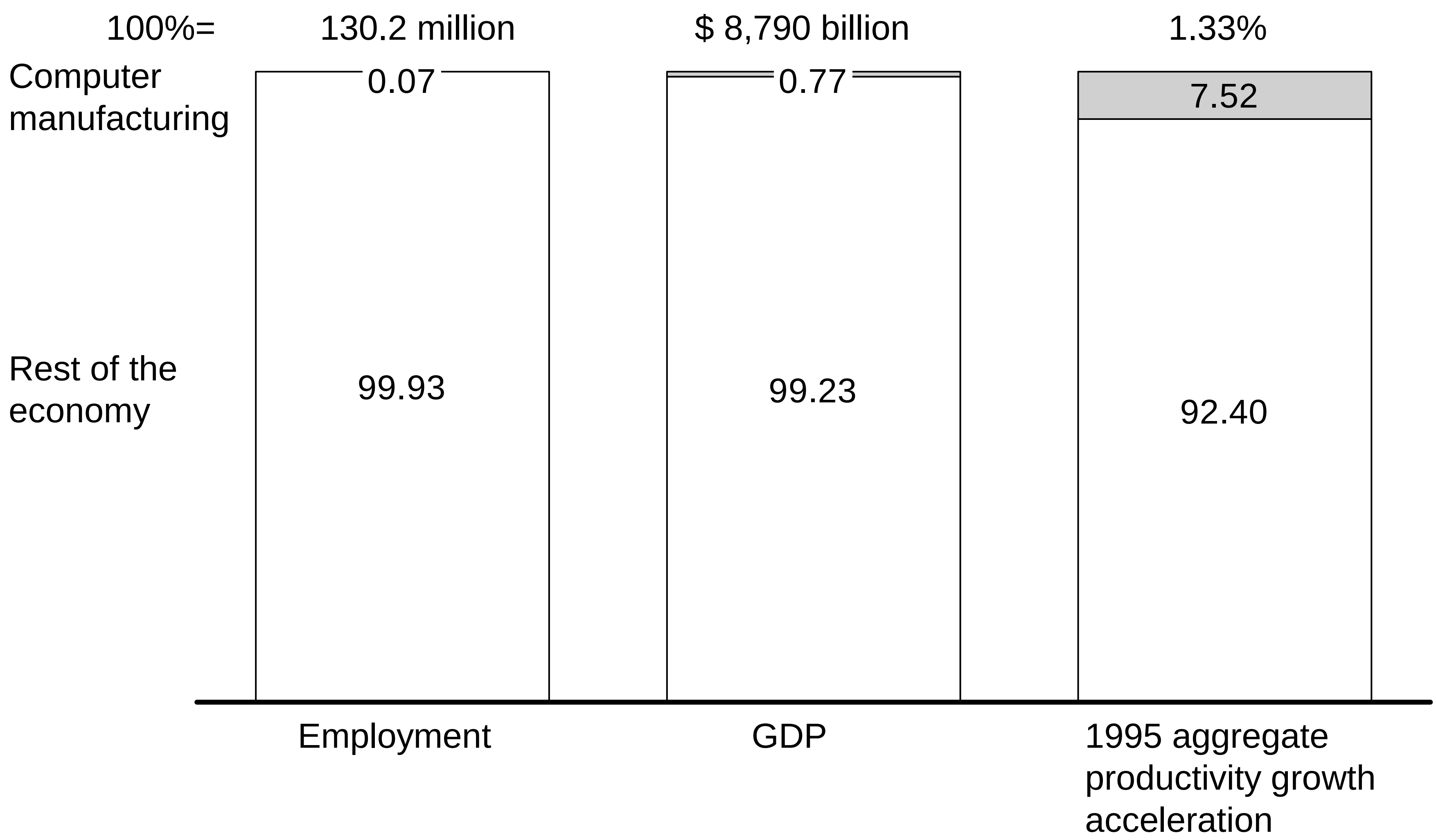
Exhibits

October 3, 2001

Exhibit 1

RELATIVE IMPORTANCE OF COMPUTER MANUFACTURING INDUSTRY

1998 percent share

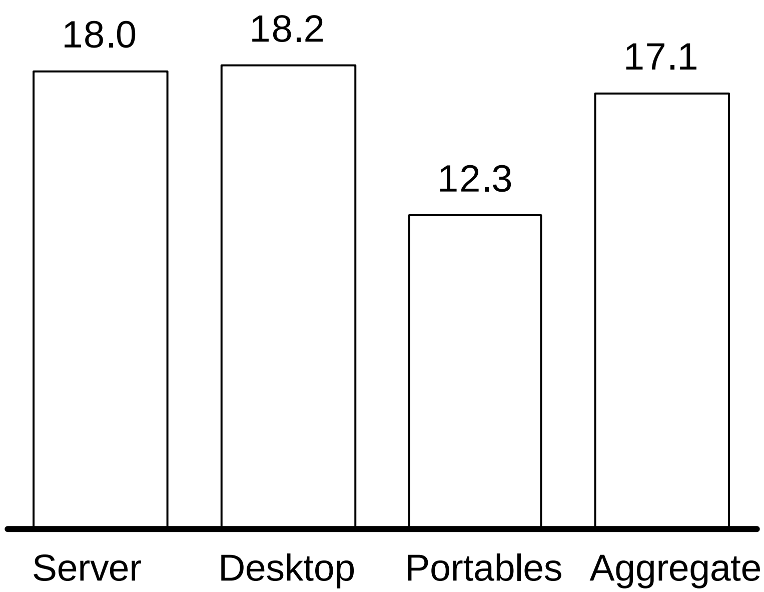


Source: BEA; NBER; BLS; MGI analysis

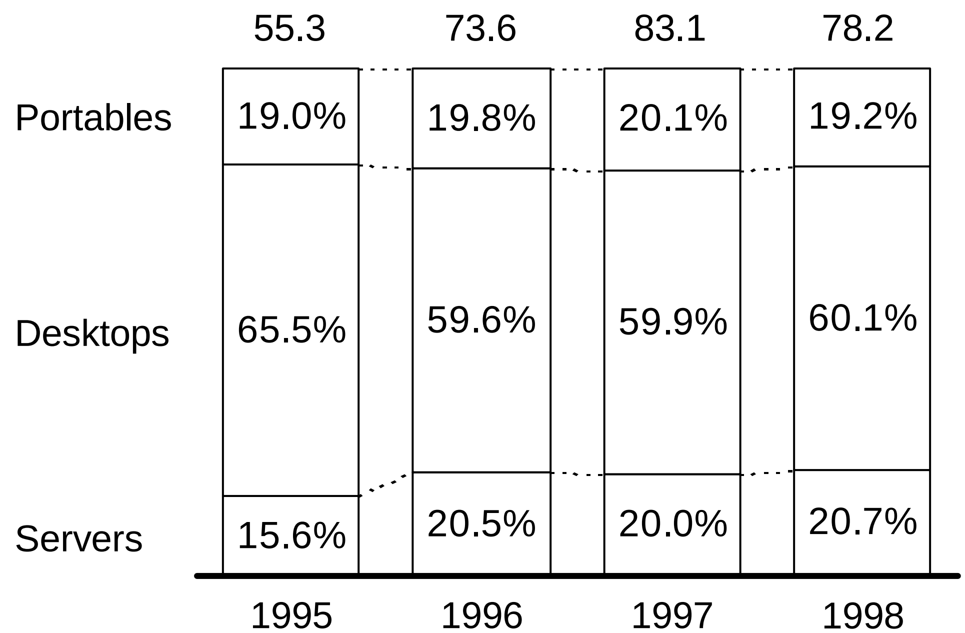
Exhibit 2

COMPUTER MANUFACTURING BY PLATFORM: 1995-98

Growth in units by platform
CAGR 1995-98



Revenue share by platform
$ Billions

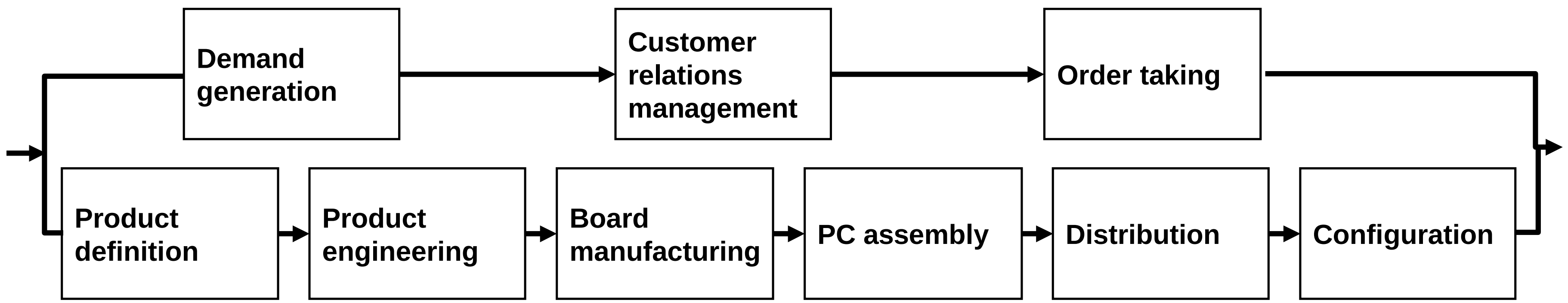


Source: Dataquest; MGI analysis

Exhibit 3

COMPUTER MANUFACTURING PROCESS

Current practice

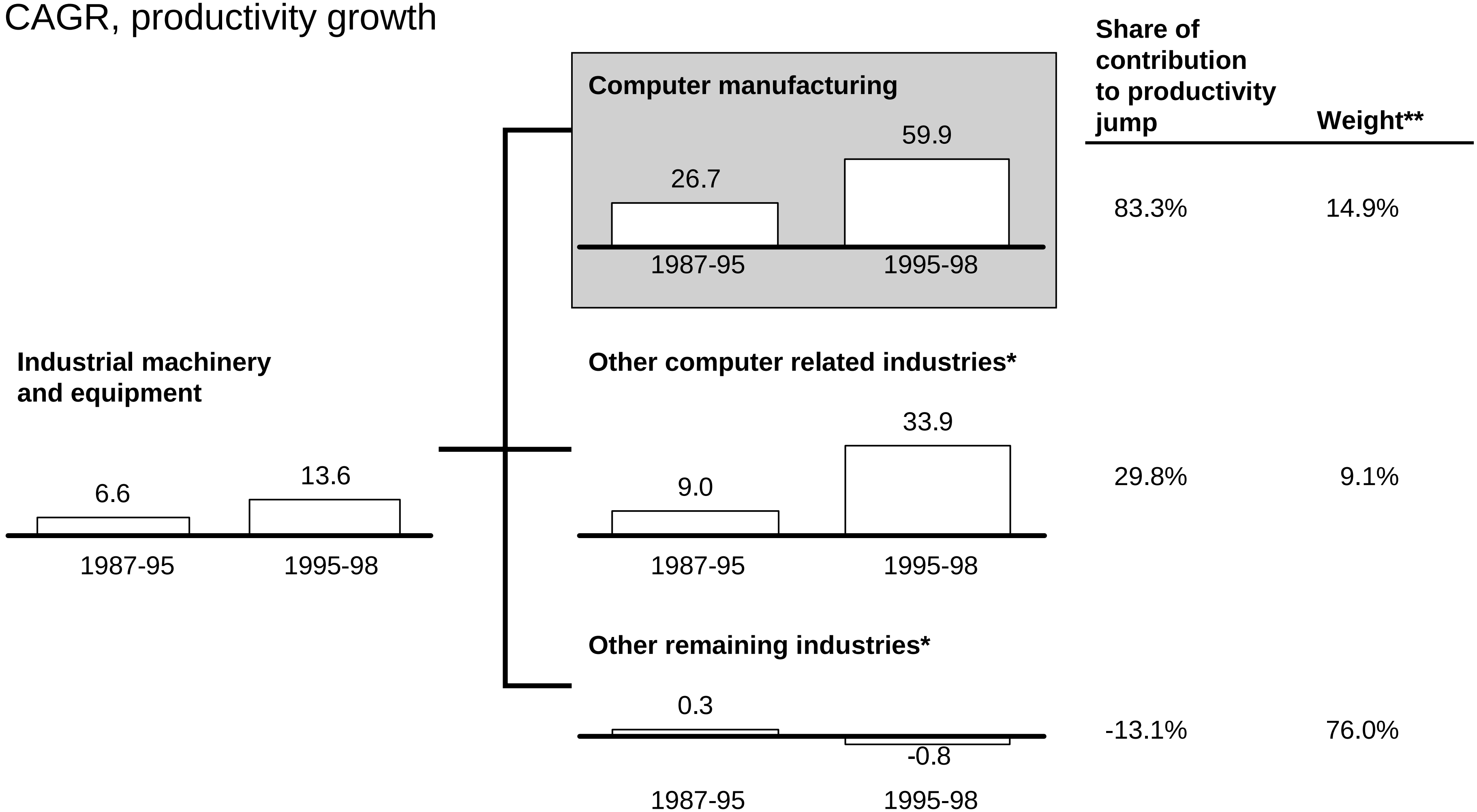


Source: MGI analysis

Exhibit 4

COMPUTER MANUFACTURING CONTRIBUTES 83% OF PRODUCTIVITY JUMP IN INDUSTRIAL MACHINERY AND EQUIPMENT

CAGR, productivity growth



* Assumes percent of SIC 35 sales is equal to percent of SIC 35 value added for each sector.

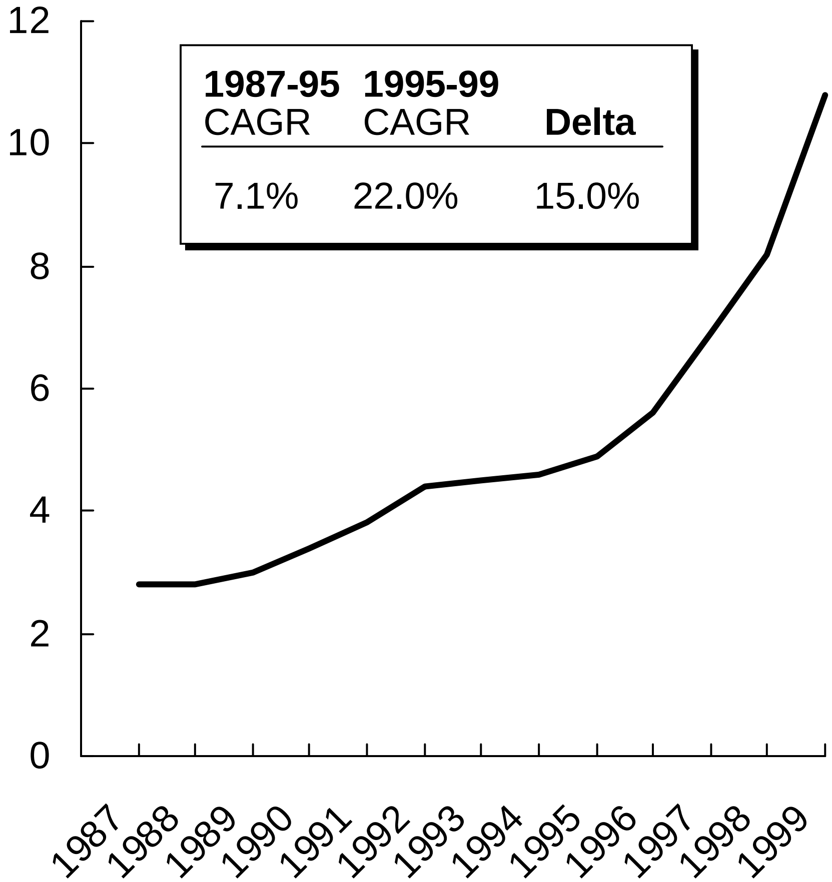
** Percent of SIC 35 sales in 1992

Source: U.S. Census; BEA; NBER; BLS; MGI analysis

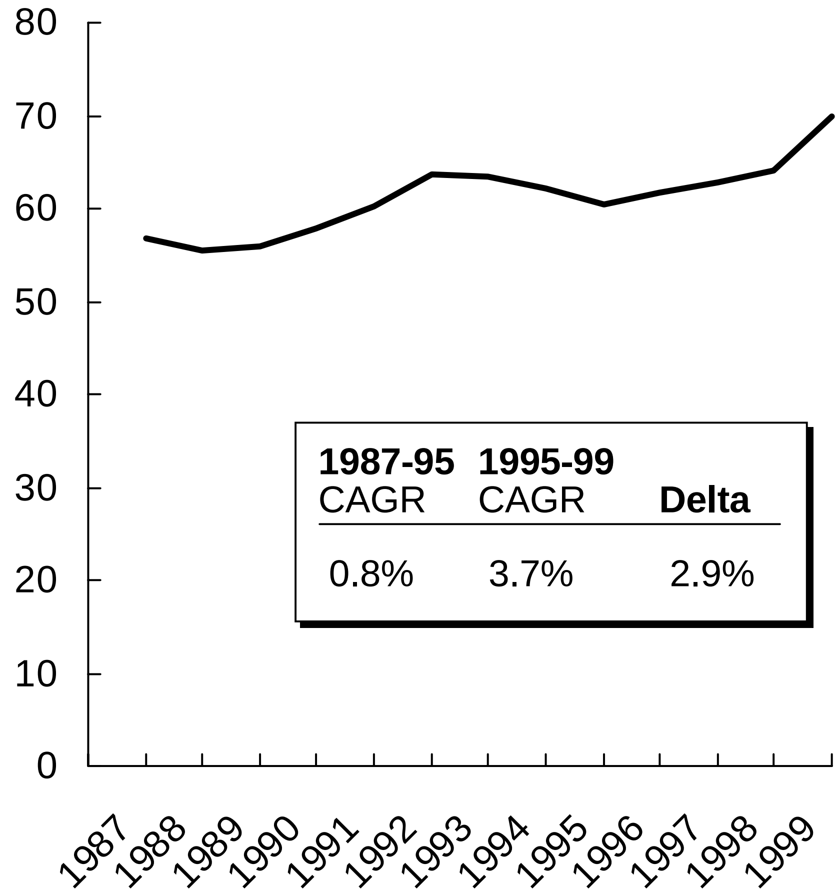
Exhibit 5

IT AND TOTAL CAPITAL INTENSITY GROWTH FOR INDUSTRIAL MACHINERY AND EQUIPMENT SECTOR ACCELERATED

IT capital intensity
1996 $ Thousands per employee



Total capital intensity
1996 $ Thousands per employee

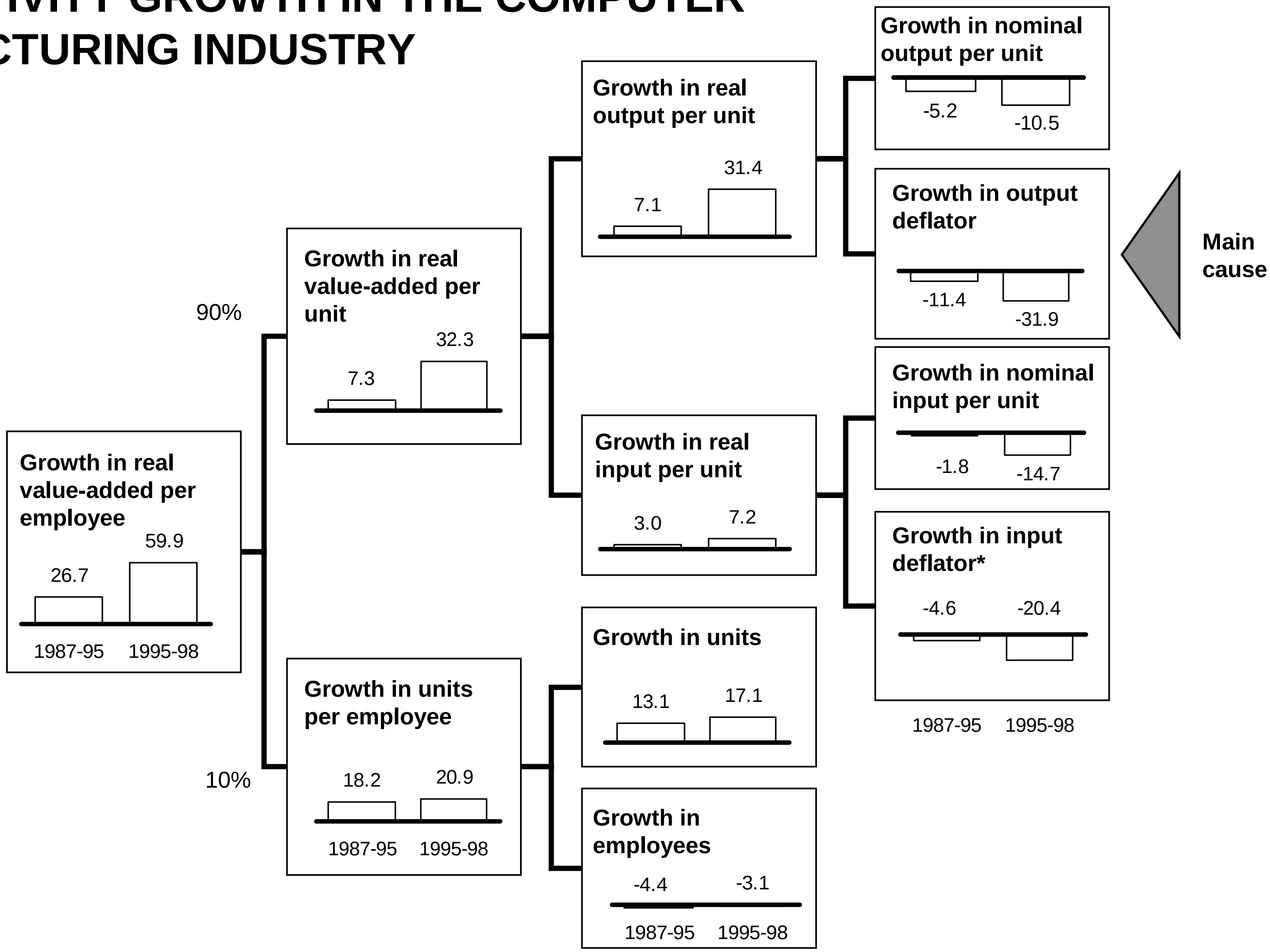


Source: BEA; MGI analysis

Exhibit 6

PRODUCTIVITY GROWTH IN THE COMPUTER MANUFACTURING INDUSTRY

CAGR



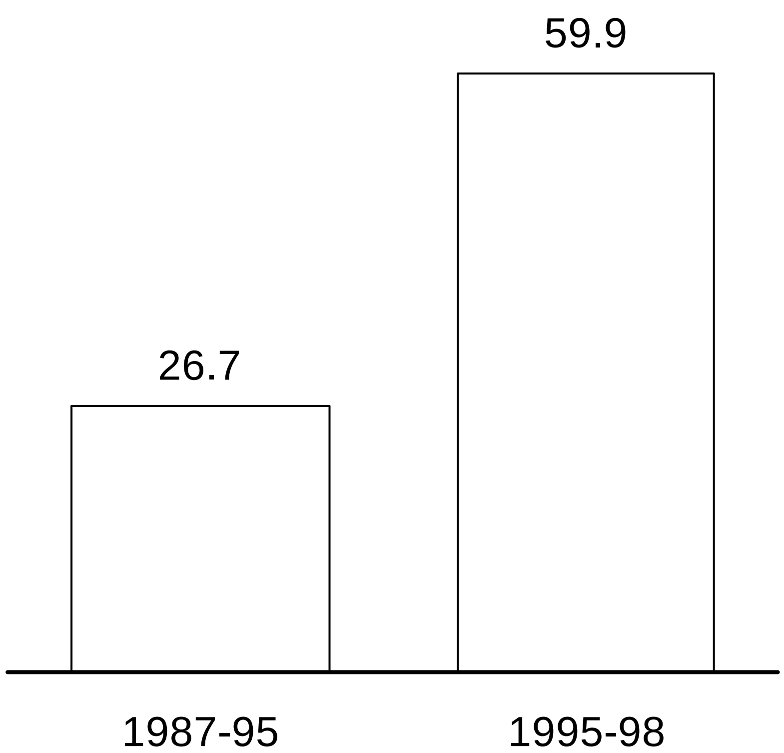
* No input deflator available for 1997 and 1998. Input price deflator decreased by 13.3% in 1996. We assume price of inputs decreases at 23.7% CAGR for 1997 and 1998 to take into account the faster decline in microprocessors due to higher levels of competition in 1997 (see semiconductor case for details).

Source: NBER; U.S. Bureau of Census; Dataquest; BLS; MGI analysis

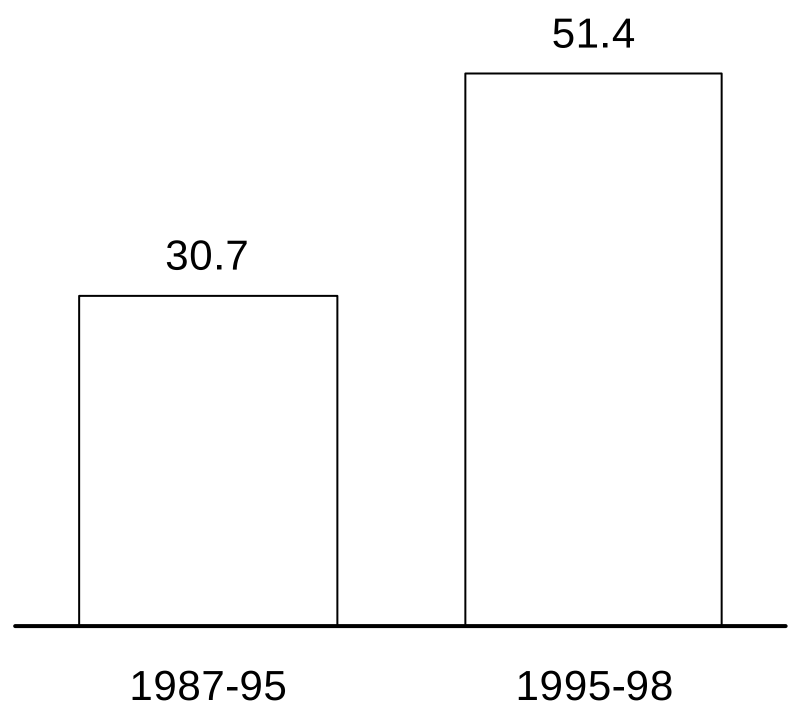
Exhibit 7

COMPARISON OF MGI AND BLS PRODUCTIVITY GROWTH RATES

MGI real value-added per employee
CAGR



BLS real gross output per employee
CAGR



Source: BLS; MGI analysis

Exhibit 8

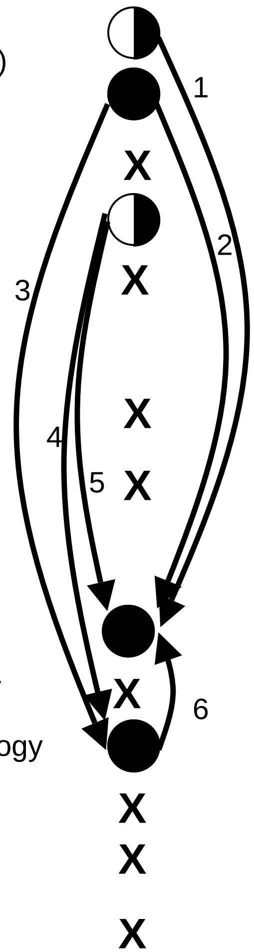
CAUSALITY SUMMARY FOR COMPUTER MANUFACTURING

- Important (>50% of acceleration)
- Somewhat important (10-50% of acceleration)
- Not important (<10% of acceleration: asterisk to right indicates significant negative)

External factors
- Demand factors (Macro-economic/financial markets)
- Technology/innovation
- Product market regulation
- Up/downstream industries
- Measurement issues

Industry dynamics
- Competitive intensity
- Prices/demand effects

Firm-level factors
- Output mix
- Capital/technology/capacity
- Intermediate inputs/technology
- Labor skills
- Labor economies of scale
- OFT/Process design



Comments

1. Factors leading to higher demand for higher quality/capability computers
   – IT budget tied to revenue growth
   – IT investment boom

2. New technological innovations in the use of computers
   – More powerful standard operating system and software
   – Internet / connectivity

3. Technological improvements in manufacturing of hard disks, CD-ROM/DVD, modems, network cards, microprocessors, etc. are resulting in improved inputs and faster roll out of "cutting edge" microprocessors

4,5. Upstream competition in the input markets (e.g., Intel/AMD, DRAM) are causing faster roll out of "cutting edge" technology and lower input prices which enable computer manufacturers to deliver more capability by using more inputs (e.g., more memory)

6. Technological improvements in inputs allow for higher quality computer for each type of computer platform

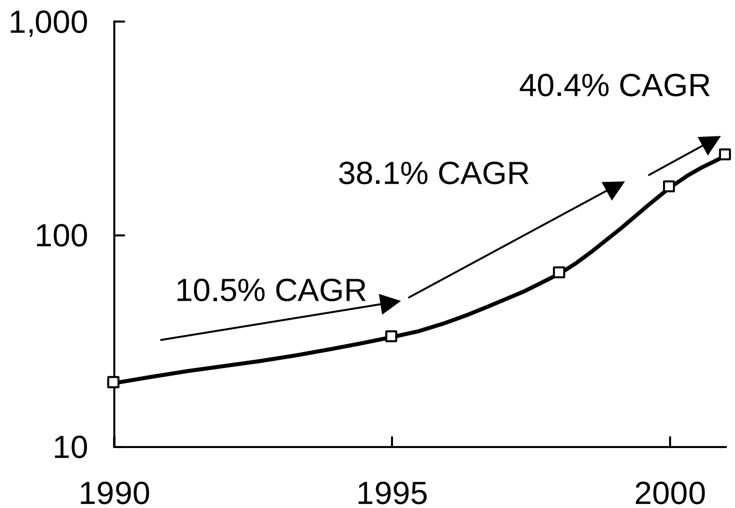
Exhibit 9

MORE DEMANDING OPERATING SYSTEMS HAVE REQUIRED MORE POWERFUL COMPUTERS

	1990 Windows 3.0	**1995** Windows 95	**1998** Windows 98 2nd edition	**2000** Windows ME	**2000** Windows 2000 professional	**2001** Windows XP professional	**1990-95 CAGR** Percent	**1995-2000 CAGR** Percent	**2000-01 CAGR** Percent	**1990-2001 CAGR** Percent
Process/speed required	80386SX/20MHZ	80486/33MHZ or higher	80486DX/66MHZ or higher	Pentium/150MHZ or higher	Pentium/166MHZ or higher	Pentium/233MHZ	10.5	38.1	40.4	25.0
Minimum memory	2MB RAM	4MB RAM	24MB RAM	32MB RAM	32MB RAM	64MB RAM	14.9	51.6	100.0	37.0
Minimum disk space			210MB to 305MB	480MB to 645MB	2GB or larger	1.5 GB				

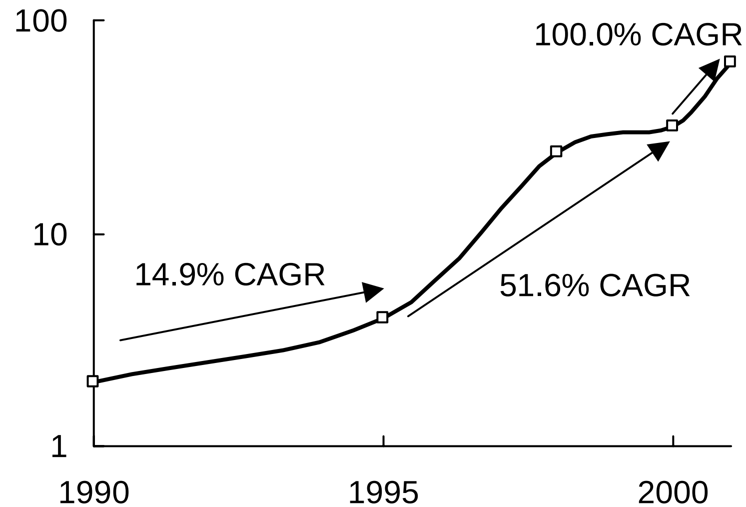
Processor speed requirement

MHZ



Minimum memory requirement

RAM



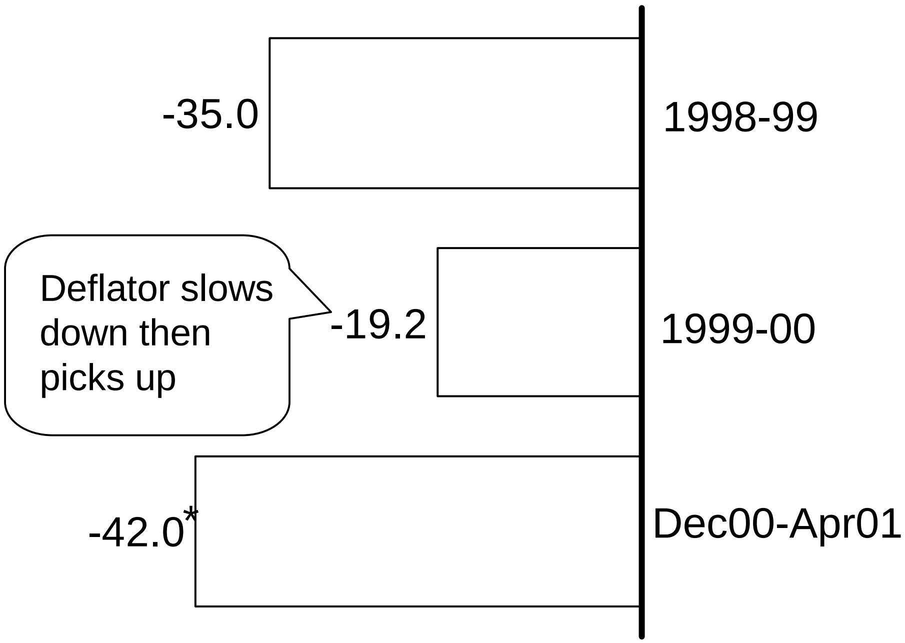
Source: Microsoft; Datapro

Exhibit 10

THE STREAM OF INNOVATIONS AND INPUT MARKET COMPETITION LOOK SUSTAINABLE INTO THE IMMEDIATE FUTURE

Recent trends in the computer deflator

CAGR



Beyond 2000

- PC inventory glut is causing price war
- Intel's announcement that it may reduce prices of their top microprocessors by over 50% in late August of 2001
- By 2003, Intel will move to 0.13 micron technology and a 3,000 MHz** clock speed
- Extreme Ultraviolet Lithography (EUV) technology, just recently prototyped, will drive Moore's law and push etching down to 0.01 microns (vs. 0.18 microns today)

* Annualized

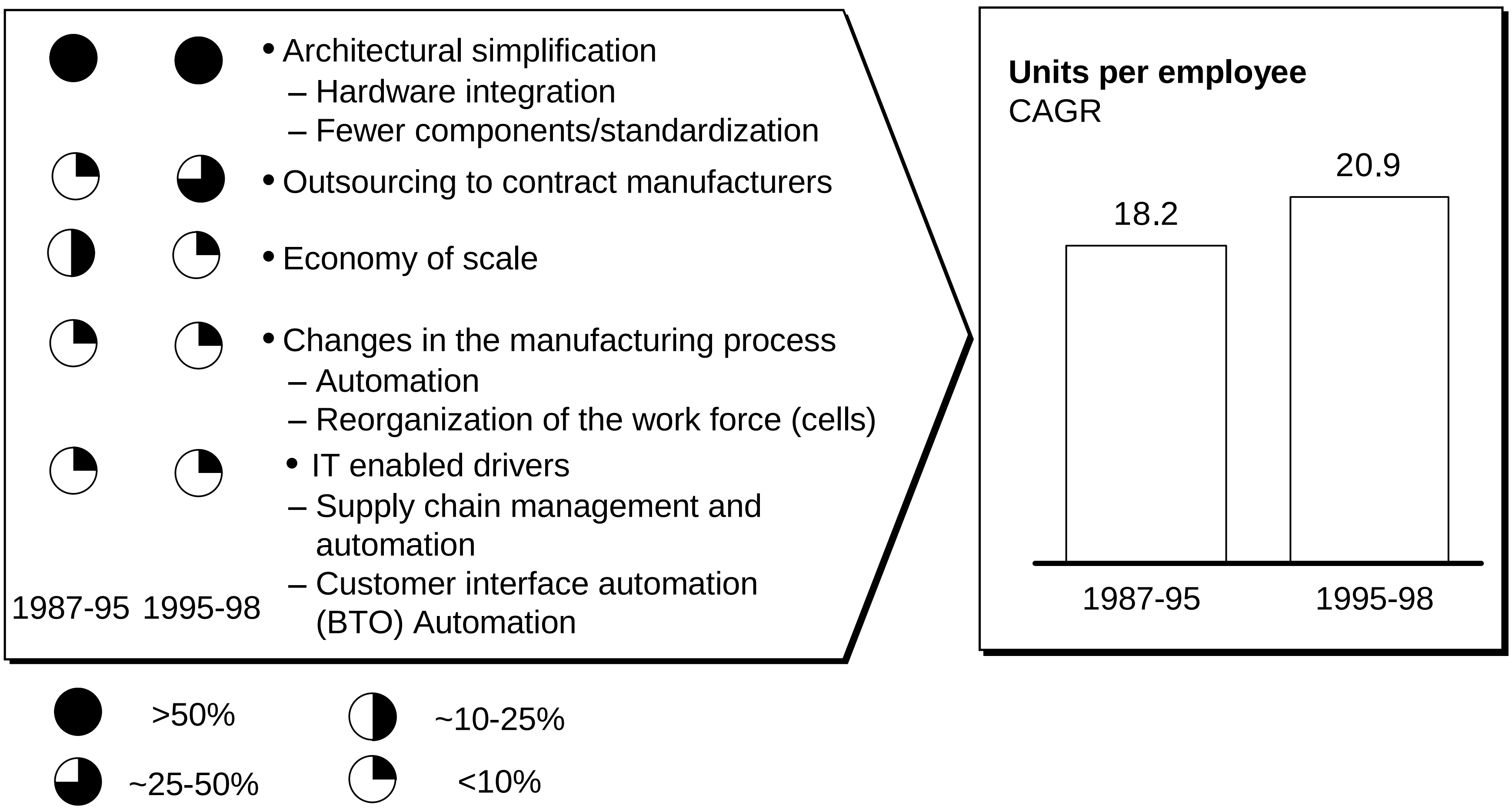
** For each additional MHz of clock speed, ~1 million additional instructions are executed per second; number of transistors not yet announced for 2003 chip

Source: Intel; Scientific American, BLS

Exhibit 11

DRIVERS OF UNIT BASED PRODUCTIVITY GROWTH IN COMPUTER MANUFACTURING

Contributions of drivers to unit-based productivity growth



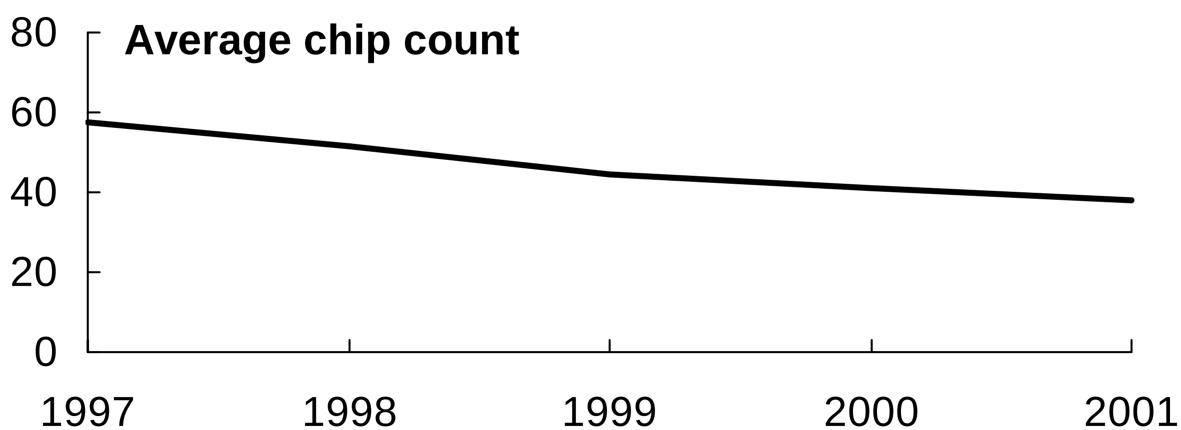
Source: Interviews; MGI analysis

Exhibit 12

WITH EACH NEW GENERATION, THE NUMBER OF SEMICONDUCTOR COMPONENTS DECREASES

Desktop PC average chip counts by price band

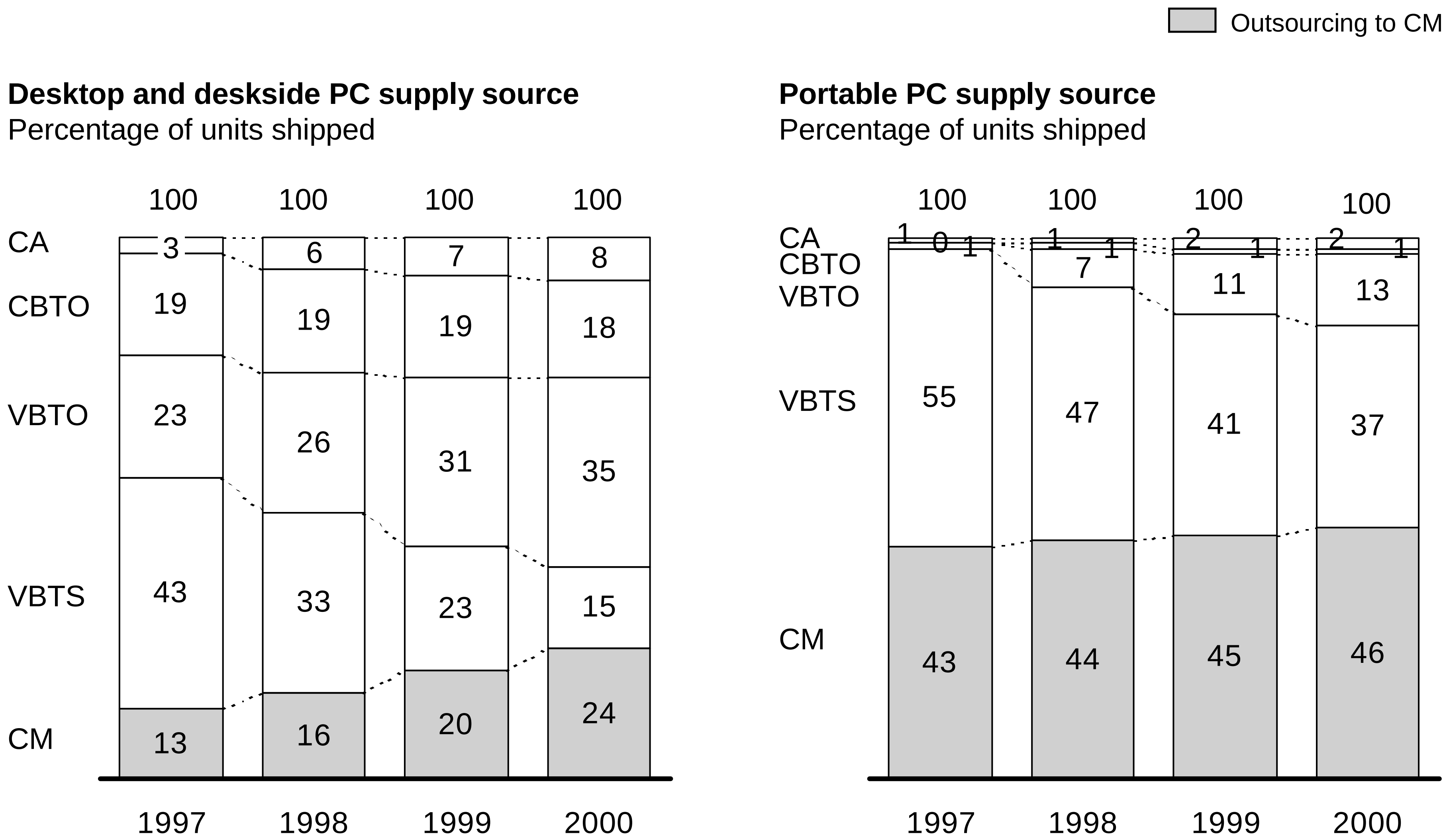
PC price band	**1997**	**1998**	**1999**	**2000**	**2001**	**1997-2001 CAGR** Percent
<$800 PC	39.5	37.6	29.6	25.5	25.6	-10.3
$800-999 PC	43.6	43.8	30.2	27.4	28.6	-10.0
$1,000-1,499 PC	52.0	55.5	42.4	38.3	33.4	-10.5
$1,500-1.999 PC	62.4	48.9	46.9	46.7	41.5	-9.7
$2,000-2,500 PC	62.2	51.1	46.7	44.4	45.0	-7.8
>$2,500 PC	86.6	73.6	71.3	63.9	55.3	-10.6
Average	**57.7**	**51.7**	**44.5**	**41.0**	**38.2**	**-9.8**



Source: IDC

Exhibit 13

CONTRACT MANUFACTURING IS BECOMING MORE IMPORTANT



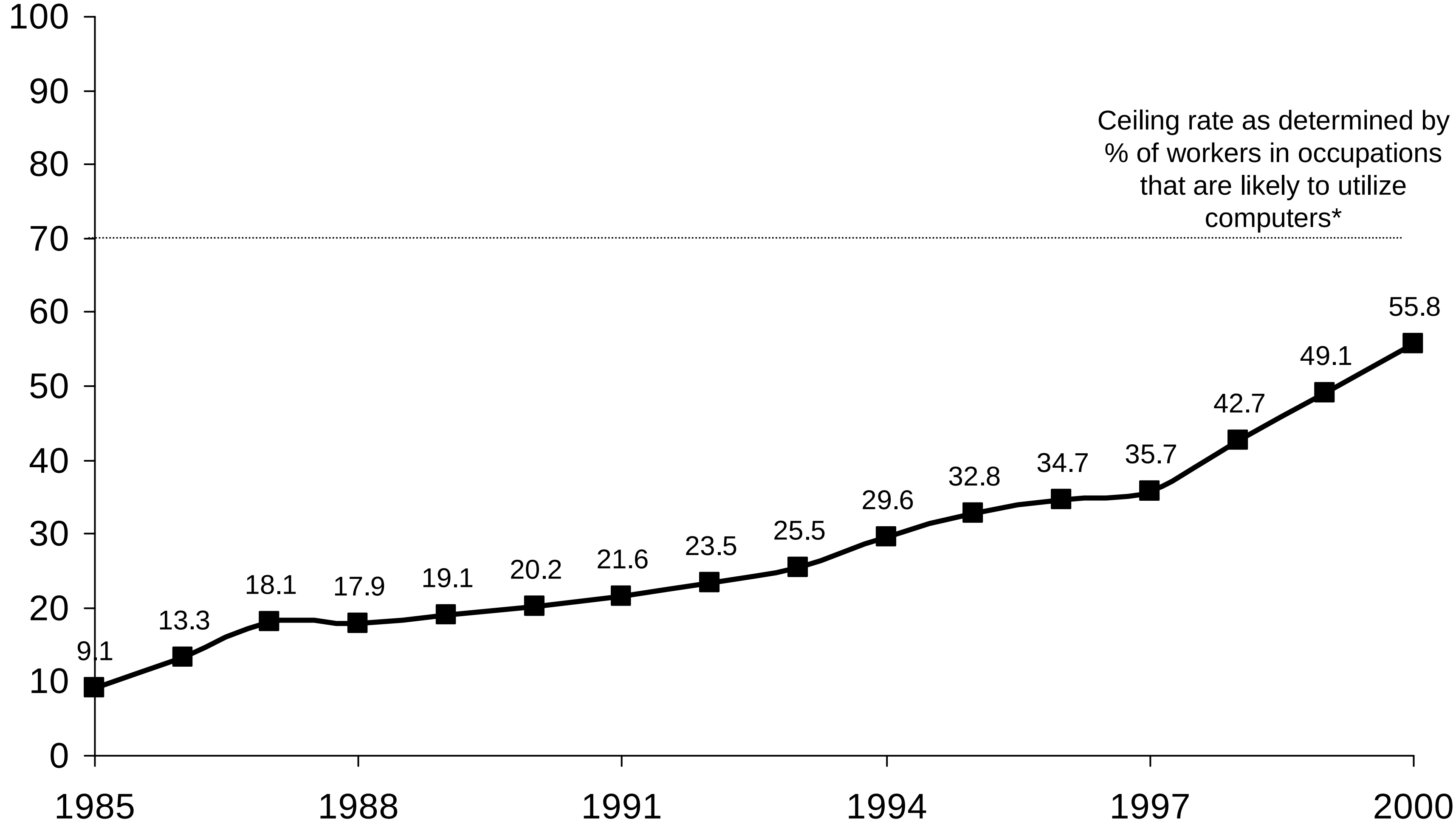
* VBTO: Vendor Build to Order; CBTO: Channel Build to Order; CA: Channel Assembly;
CM: Contract manufactured; VBTS: Vendor Build to Stock

Source: Dataquest; MGI analysis

Exhibit 14

BUSINESS PC PENETRATION IS ALREADY NEAR ITS UPPER CEILING

Percentage of persons engaged in production



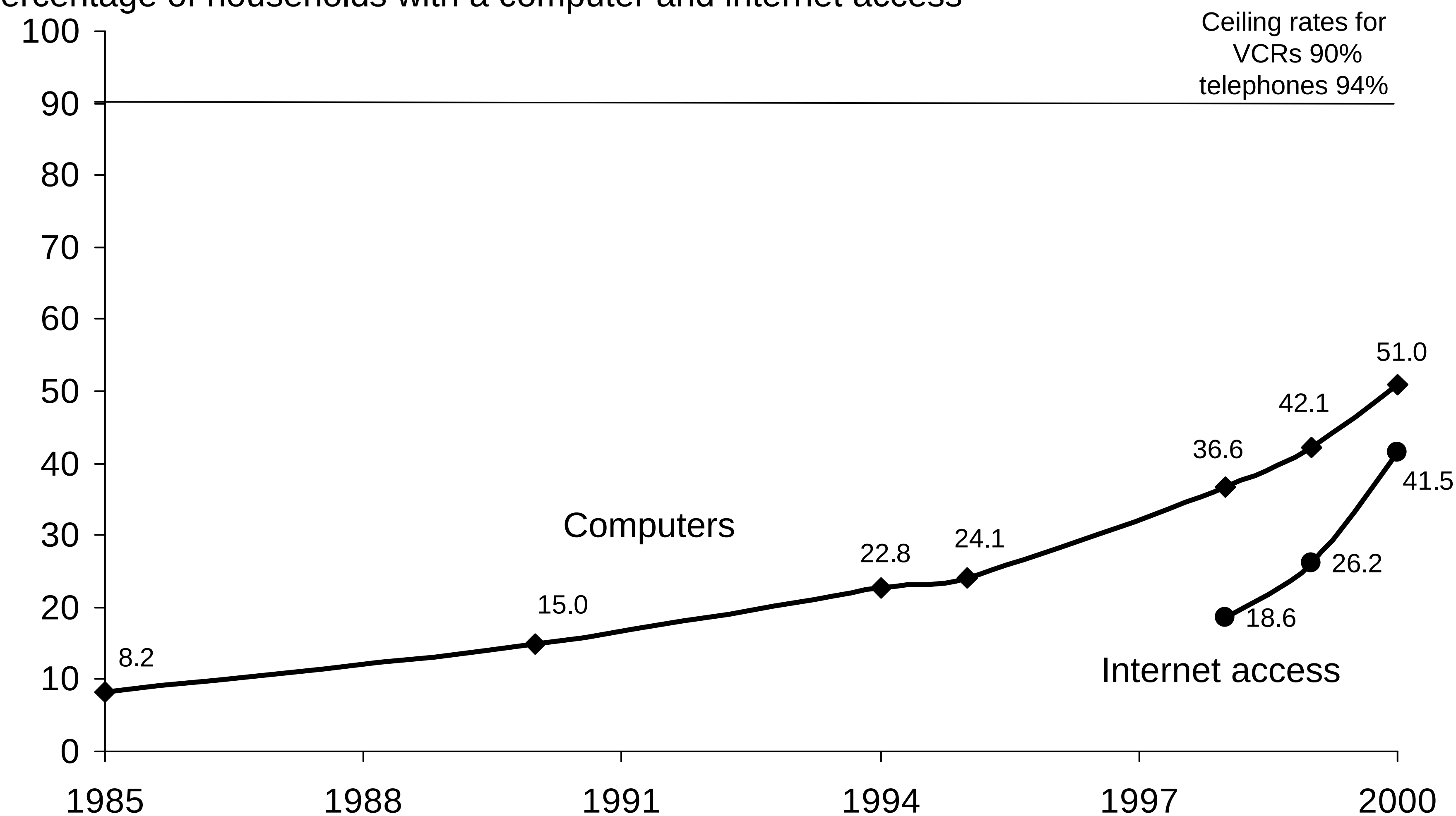
* BLS Occupation-Industry matrix reveals that ~70% of employees are in occupations that are likely to benefit from direct utilization of computers.

Source: IDC; MGI analysis

Exhibit 15

COMPUTERS COULD EVENTUALLY REACH HOUSEHOLD PENETRATION RATES OF VCRS AND TELEPHONES

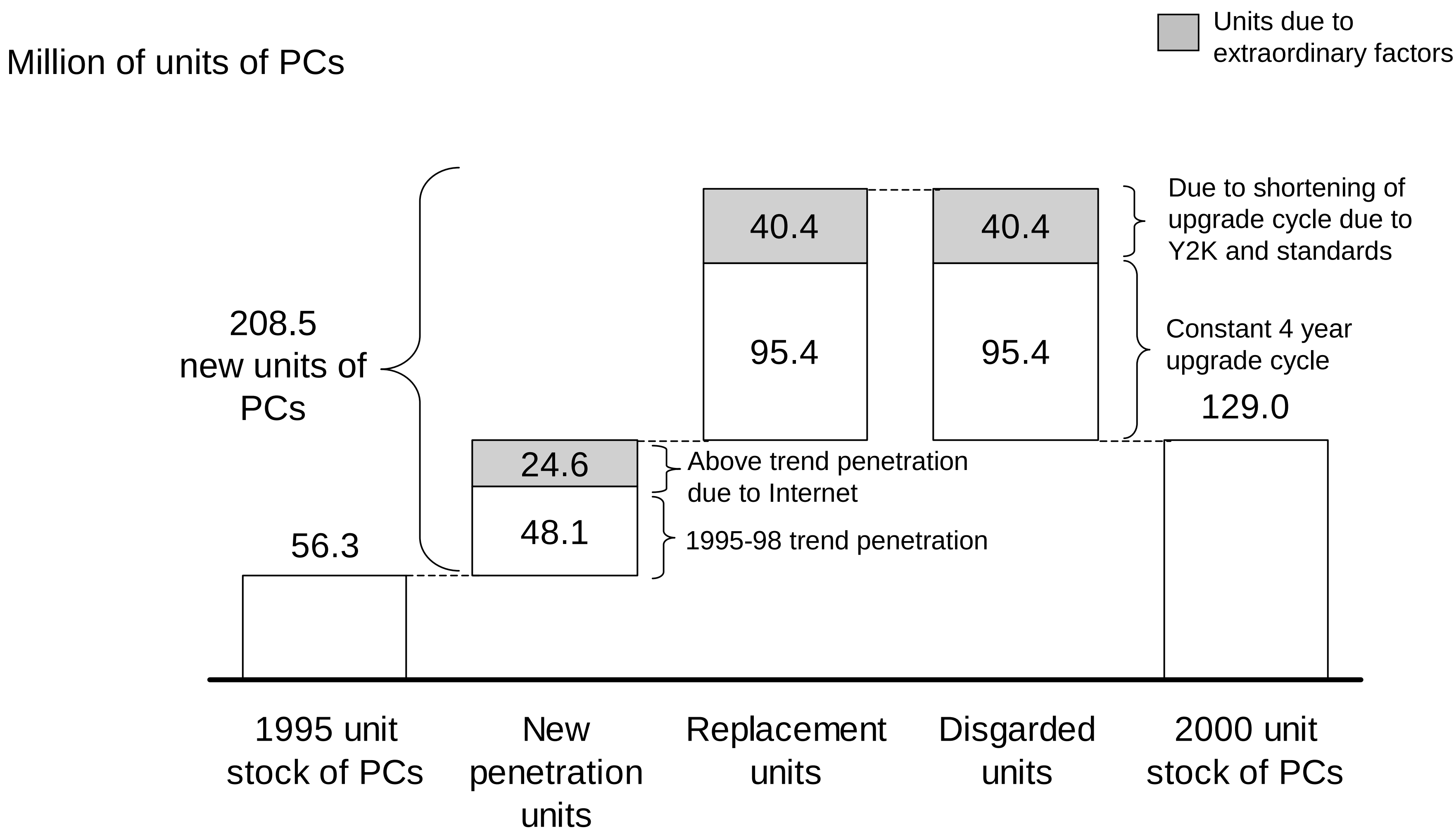
Percentage of households with a computer and internet access



Source: U.S. Census Current Population Survey

Exhibit 16

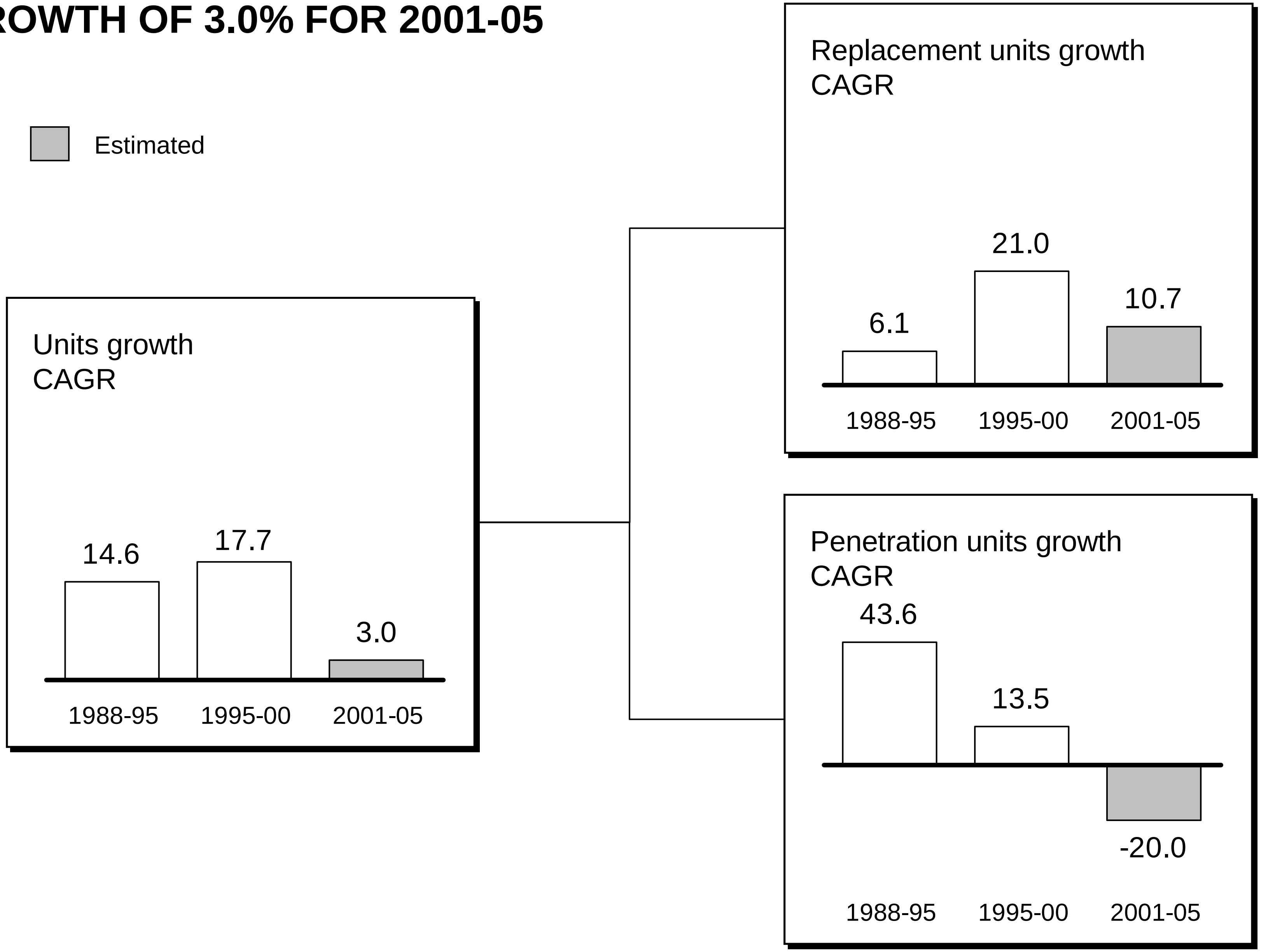
Y2K, INTERNET, AND SOFTWARE STANDARDS DRIVE 65 MILLION OUT OF 208 MIILION IN PC UNIT SALES



Source: IDC; MGI analysis

Exhibit 17

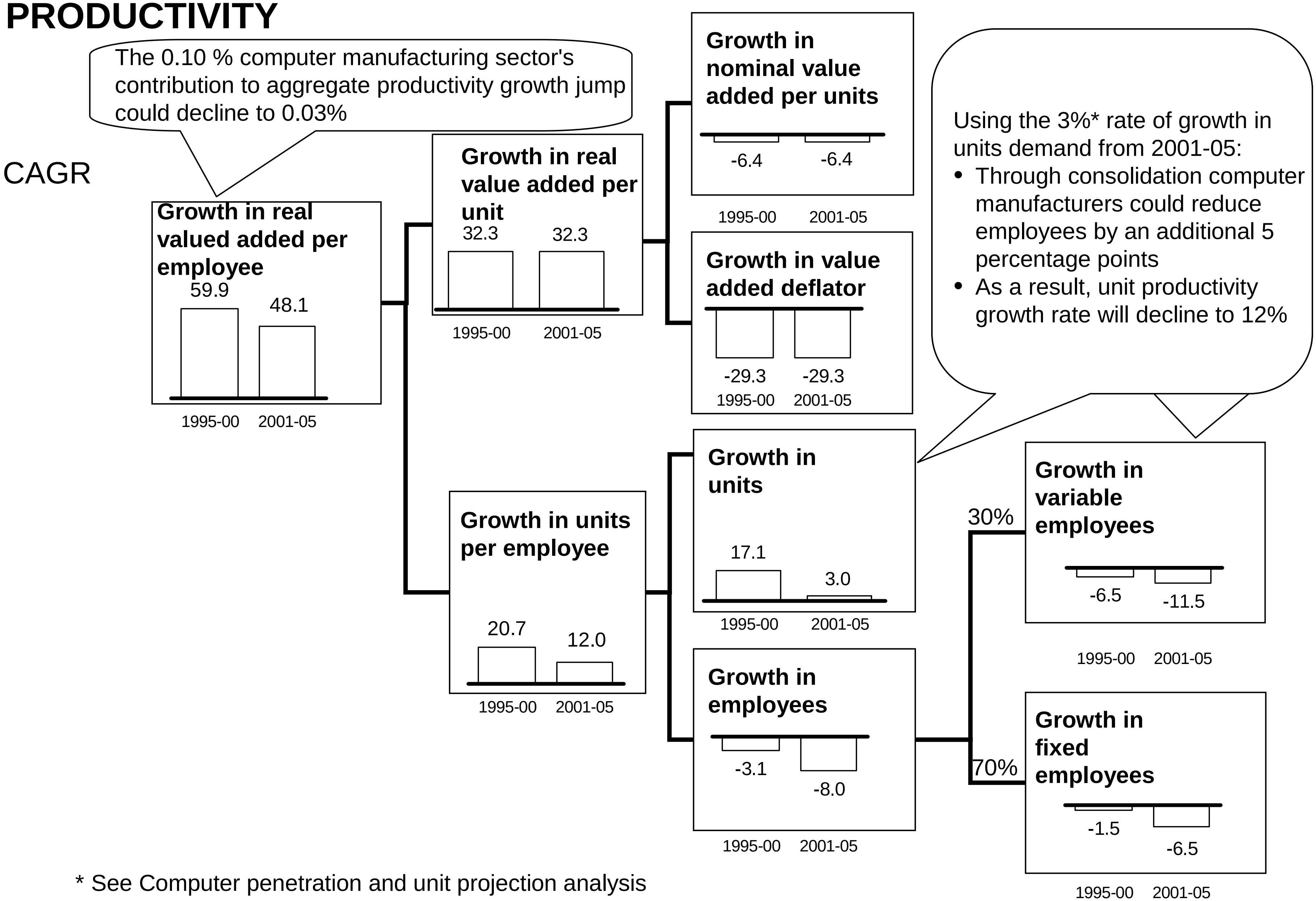
THE TRAJECTORY OF PC PENETRATION RESULT IN ESTIMATED UNITS GROWTH OF 3.0% FOR 2001-05



Source: MGI analysis

Exhibit 18

SUSTAINABILITY OF COMPUTER MANUFACTURING VALUE-ADDED PRODUCTIVITY

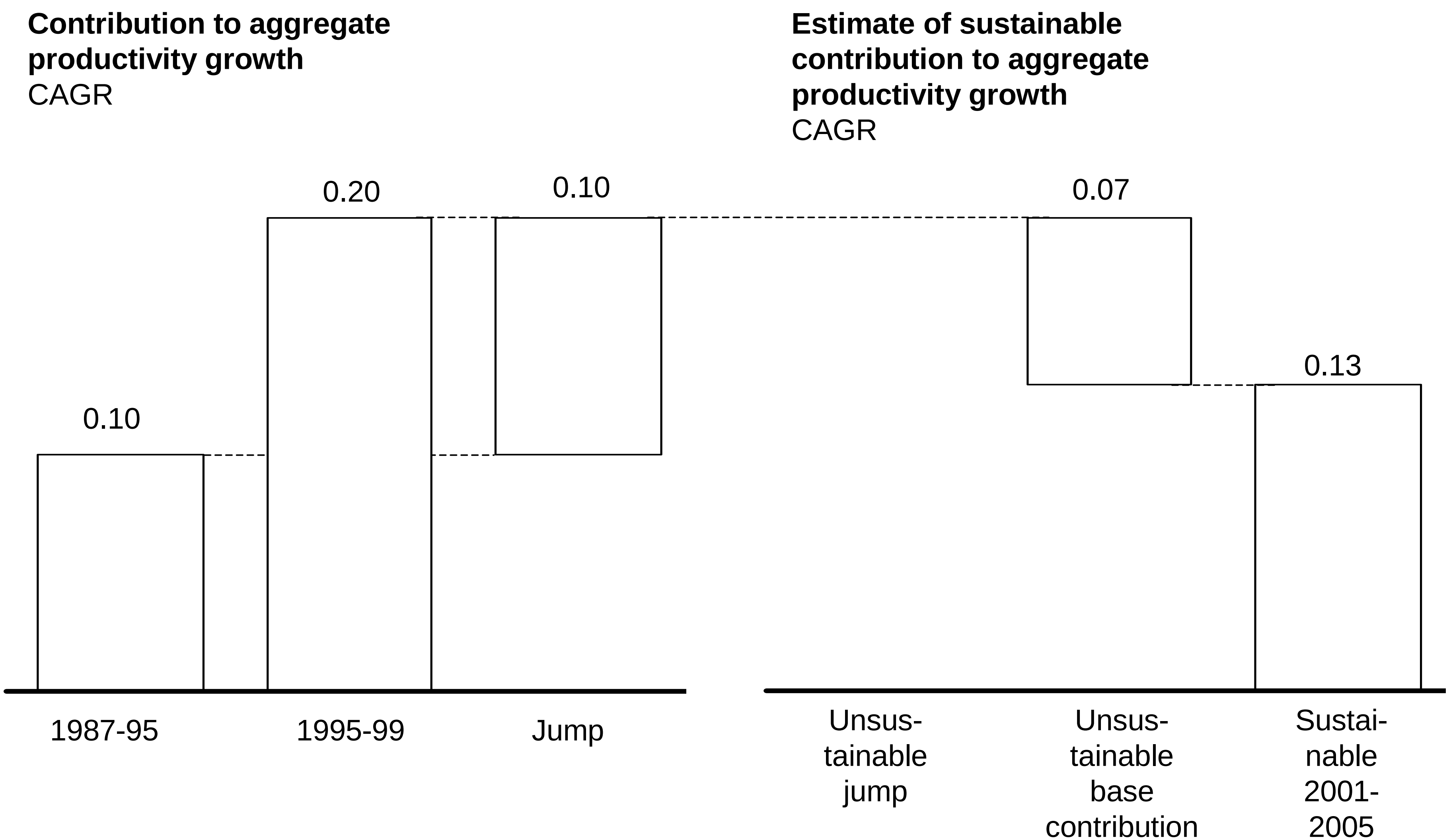


* See Computer penetration and unit projection analysis

Source: IDC; MGI Analysis

Exhibit 19

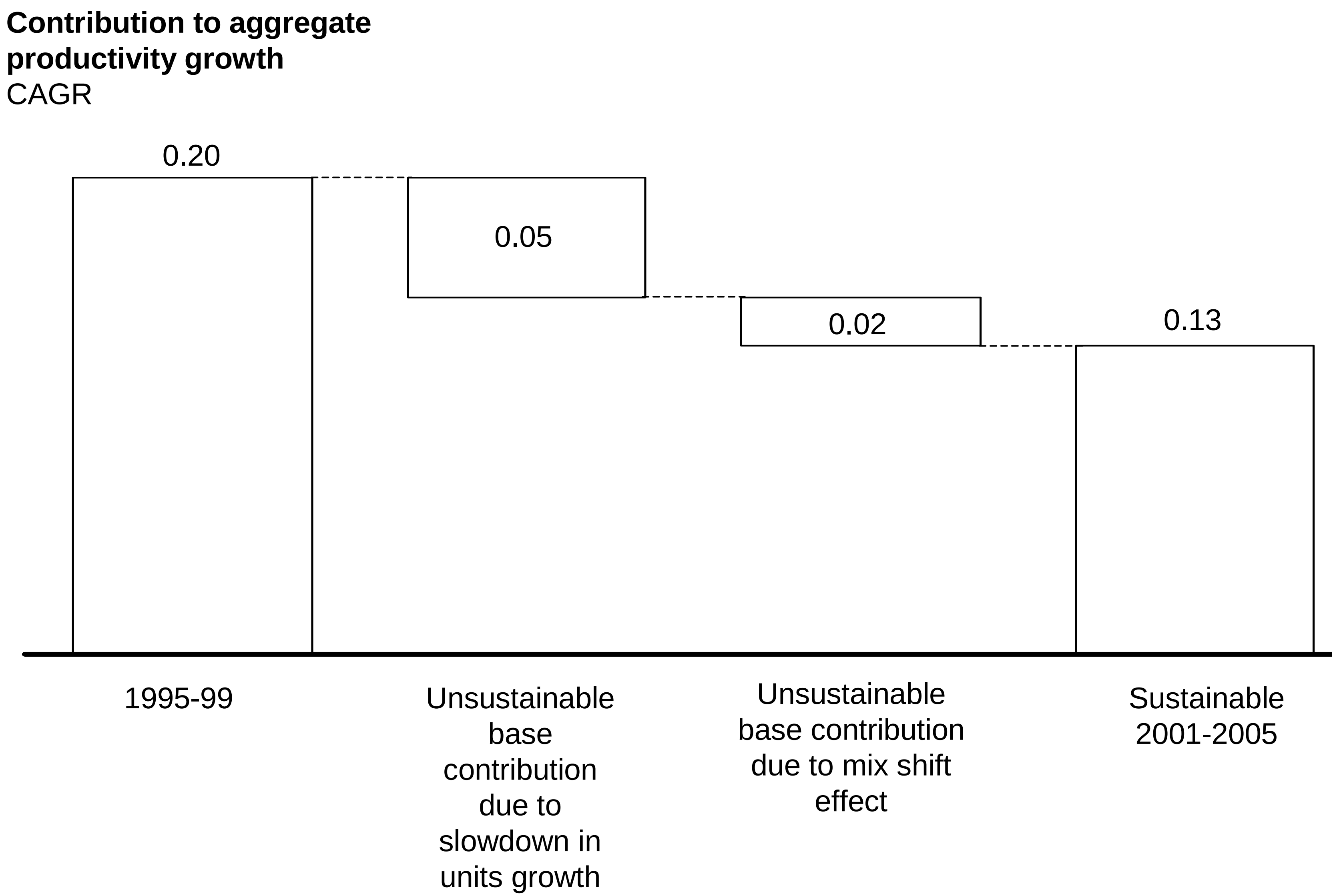
SUSTAINABILITY OF CONTRIBUTION OF COMPUTER MANUFACTURING SECTOR TO AGGREGATE PRODUCTIVITY GROWTH



Source: MGI analysis

Exhibit 20

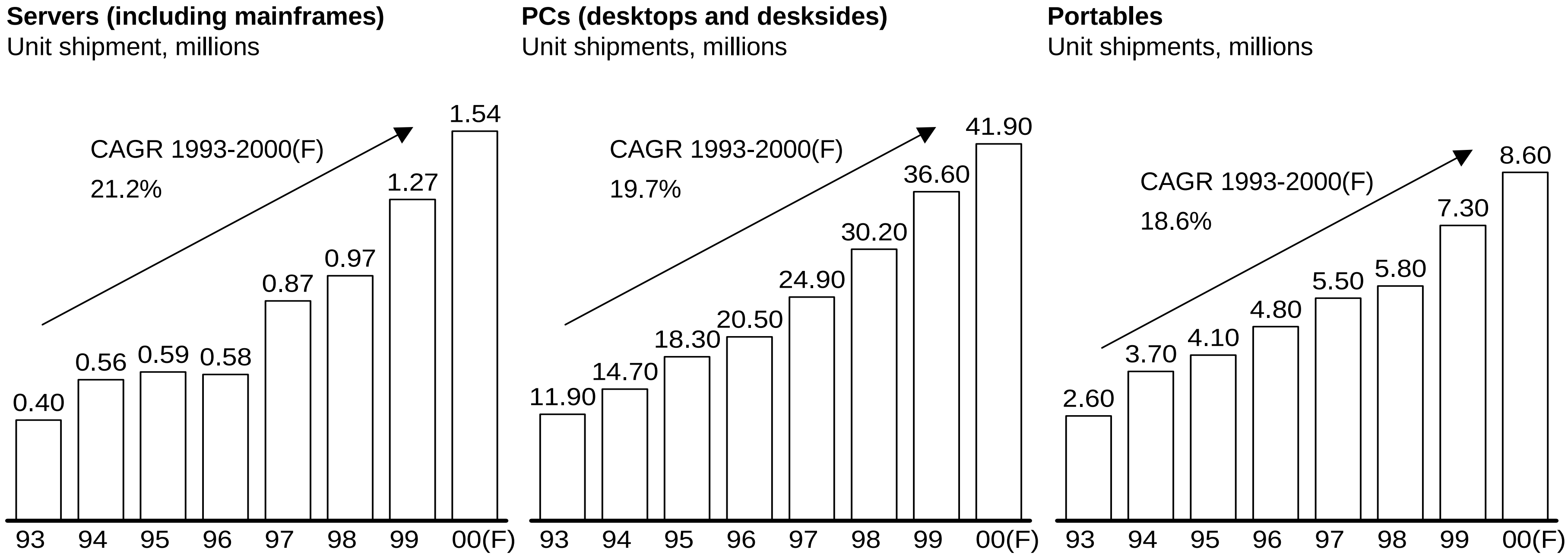
SUSTAINABILITY OF CONTRIBUTION OF COMPUTER MANUFACTURING SECTOR TO AGGREGATE PRODUCTIVITY GROWTH



Source: MGI analysis

Exhibit A1

PHYSICAL UNITS OF COMPUTERS PRODUCED IN THE U.S. HAVE BEEN INCREASING AT ALMOST 20% SINCE 1993

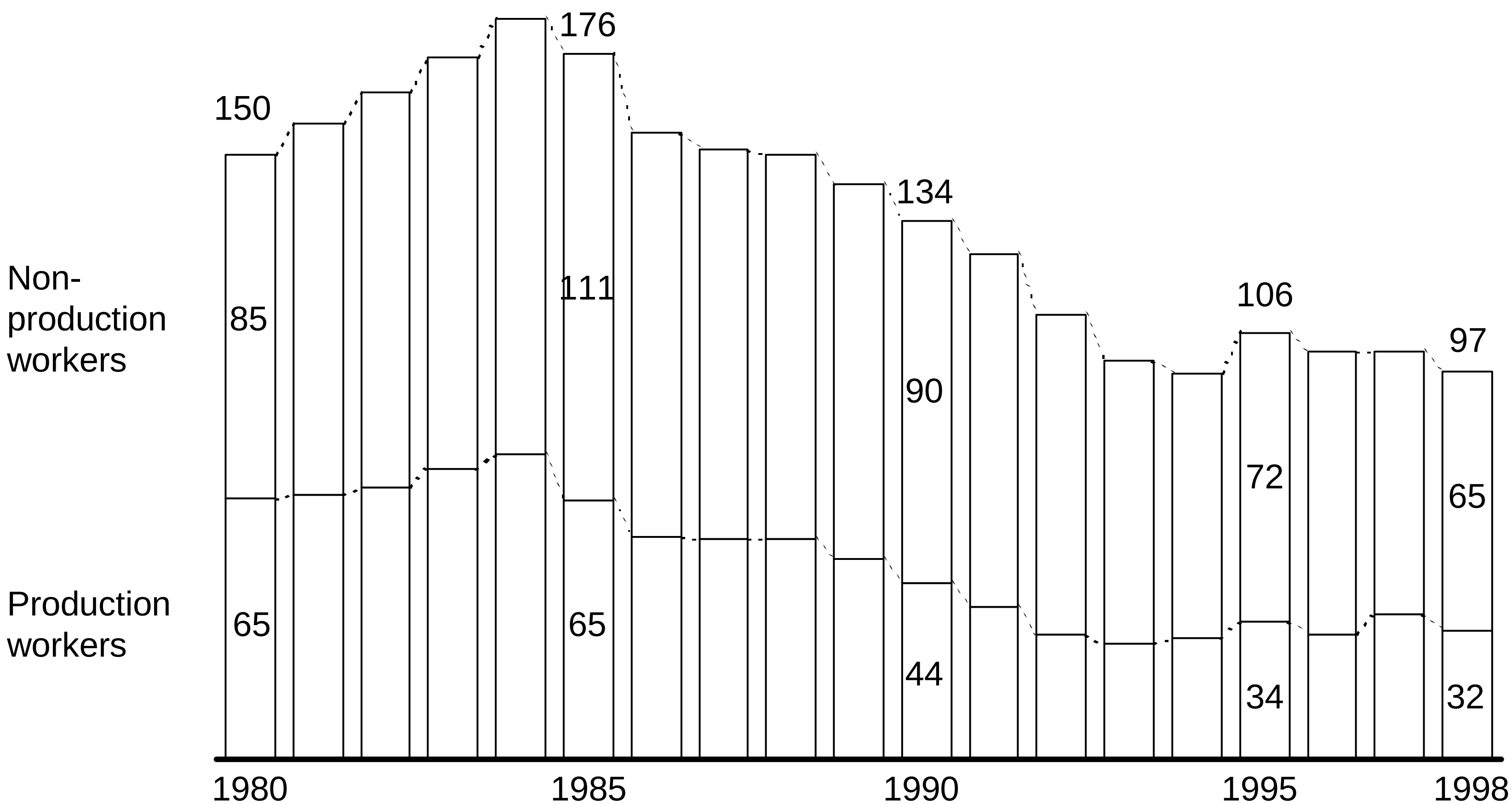


Source: Dataquest (Server Computing and Personal Computers Report); MGI analysis

Exhibit A2

EMPLOYMENT IN THE COMPUTER INDUSTRY HAS BEEN SHRINKING

Thousands of workers



Source: NBER, U.S. Bureau of Census ASM; MGI analysis

Exhibit A3

BLS HEDONIC PRICE ADJUSMENT METHODOLOGY

Hedonic methodology

- Computer price data is collected, analyzed, and the resulting coefficients are used to adjust the PPI data
  - Sample size is always over 600 data points
  - Sampled based on the type of products used in the PPI
  - 4 hedonic models
    - Personal desktop computers
    - Portable computers
    - Entry-level/mid-range computer servers
    - Large-scale computers
- PC Price data and configuration data is collected from reporting companies
  - 10-11 manufactures report, sampled based on labor size
  - Total of ~50 different products reported, sampled within a manufacturer based on product volume

- The BLS's hedonic methodology and data appear reliable
  - BLS has not changed its methodology for assembling the PC PPI since it began using hedonics in 1990
  - There is no clear systemic bias in the output of the hedonic models
  - There is no other known way to better estimate the changes in computer price-to-performance over time

Source: Interview with Michael Holdway of BLS

Telecommunications services

SUMMARY

The telecommunications sector was the sixth largest contributor to the acceleration in US private sector productivity growth after 1995. Although telecommunications firms represent only 1 percent of private sector employment, they were responsible for about 5 percent of the total US productivity acceleration.

Labor productivity in telecommunications grew by almost 8 percent per year from 1987 to 1999.[1] Although productivity growth did not accelerate, telecommunications contributed to the economy-wide productivity acceleration through a "mix effect": the sector has a much higher productivity *level* than the US average and, because it grew as a share of the economy in the late 1990s, pulled up the average US productivity level.

The telecommunications services sector illustrates how technological and regulatory change can stimulate productivity growth. Technological change has encouraged telecommunications firms to invest in newer, higher-performance equipment to build network capacity and add services. Such investment has decreased the cost and labor component of existing services and has enabled entirely new services, such as mobile telephony and data communications. Meanwhile, regulatory change has helped to create more competitive environments that foster productivity growth. The seminal event in this regard, the breakup of AT&T in 1984, eased the entry of new long distance competitors and stimulated demand; more recently the Federal Communications Commission (FCC) auctions of wireless spectrum helped to increase capacity and create more competition among mobile service providers.

The steady growth rate of telecom services productivity masks considerable change within the industry. The McKinsey Global Institute (MGI) looked at three segments of the telecom services industry – local services, long distance, and mobile communications – to gain insight into the key factors underlying productivity growth.

[1] This analysis focuses on the 1987 to 1999 time period in order to be consistent with the other industry case studies, which make extensive use of Bureau of Economic Analysis data. (This span of years was selected because the BEA changed its industry definitions in 1987, and 1999 data was the latest available at the time of this analysis.)

- Local services firms (local voice and data over copper wires and fiber) improved labor productivity growth by nearly 8 percent per year in the late 1980s and early 1990s. This productivity growth was stoked by two important regulatory shocks. First, the breakup of AT&T created a long distance industry that pushed for lower-cost local access and competed with local service providers for attractive business customers. Later, a shift from fixed rate-of-return regulation to price regulation encouraged local service providers to reduce costs. In response to these incentives, local phone companies gradually weaned themselves of excess labor and steadily increased investment in communications equipment and other IT. Local services productivity growth has slowed recently – to about 5 percent annually in the late 1990s – but is still high compared to the rest of the economy.

- Mobile telephony has grown rapidly since commercial use began in the mid-1980s and has exhibited outstanding productivity performance. From 1987 to 1995, technological improvements to cellular networks and handsets drove a virtuous cycle of lower prices and higher demand, which allowed the industry to gain scale and enabled specialization and cost reductions. In the late 1990s, FCC spectrum auctions increased capacity and allowed several new entrants. Around the same time, the widespread application of digital cellular equipment enabled better use of the available spectrum. These forces reduced prices and stimulated demand, and productivity growth accelerated to over 10 percent per year from 1995-99.

- The long distance communications industry was created with the 1982 "Modified Final Judgment" that ordered the breakup of AT&T. After a burst of intense competition and rapid output growth, the industry settled into an oligopoly structure with stable prices, moderate demand growth, and heavy investment in market share retention. Productivity increased by 5 percent per year from 1987 to 1995. After 1995, slowing employment growth and continued increases in demand allowed productivity to accelerate to approximately 9 percent annual growth.

  The data business became a significant component of long distance in the late 1990s as supply-side technological advances and exponential demand for new data services, fueled by buoyant capital markets, spurred investment by entrants. (This wave of investment began to have effects on labor productivity only in the very late 1990s, but a discussion is included in this report for completeness.)

MGI believes that the telecommunications sector's contribution to overall US productivity growth is sustainable and may in fact increase slightly over the next few years. Mobile communications usage is likely to increase, even as employment growth slows and the industry consolidates. The story is similar in long distance, where rapid increases in data communications will drive productivity. Local services are likely to continue steady productivity improvements.

OVERVIEW OF TELECOMMUNICATIONS SERVICES

Because the telecommunications services industry was one of the largest contributors to the overall US productivity growth, MGI analyzed the sector in detail. The industry study is organized as follows. First, we describe the sector and its contribution to aggregate IT investment and productivity growth. Then, we dive into a discussion of the causes of productivity growth in each of three industry subsegments: local, mobile, and long distance. (Within long distance, we further distinguish between provision of voice and data services.) In each section, we describe the industry, summarize past productivity trends, review the causes of productivity improvement, and assess future productivity growth potential.

Profile of telecommunications services sector

Telecommunications represents approximately 1 percent of private sector employment and slightly over 2 percent of total value added (GDP) in the US economy. This makes it one of the smallest sectors studied by MGI. However, the industry's cumulative investment in communications equipment and physical infrastructure makes it one of the most capital-intensive parts of the economy. In 1999, the industry's capital stock amounted to more than $500,000 per employee.

MGI's industry definition of telecom services is similar to that used by the US Bureau of Economic Analysis (BEA).[2] Telecommunications services incorporate both voice and data communications, over both wireline and wireless networks. For the purposes of this study we divide services into three main components: local services (voice and data lines into homes and businesses), mobile access (wireless voice communications), and long distance (the carriage of voice and data traffic between access carriers). Neither the MGI nor the BEA industry definition includes the production of communications equipment.

Approximately one million people were employed in the telecommunications services sector in 1999, only 10 percent more than in the early 1980s. This apparent stability masks considerable change in overall industry employment and in the share of employment for each of the major industry segments (Exhibit 1).

Likewise, the near-constant rate of productivity growth in telecom services belies considerable variance in the performance of local fixed-line service, mobile telephony, and long distance services (Exhibit 2). Mobile and long distance showed high and accelerating productivity growth. Local service labor productivity growth, while high, decelerated after 1995. More detail on each segment follows.

2 Details of the BEA and MGI industry definitions, and MGI's productivity calculations, can be found in the appendix to this chapter.

Importance of telecom services sector to the overall question

Telecom services contributed 0.07 percentage points of the overall US productivity jump of 1.33 percent, as measured with data from the BEA. This is the sixth largest contribution of any industry in the US non-farm private sector (Exhibit 3).

The contribution of telecommunications services to the aggregate US productivity growth jump resulted from a jump in the sector's share of US employment, rather than an acceleration in productivity growth within the sector.

- ¶ Productivity growth within the telecommunications sector was similar in both periods studied (1987-95 and 1995-99).
- ¶ Telecommunications employment fell in the first period, then rose in the second. Because it is capital intensive, the telecommunications sector has a much higher level of value added per employee – labor productivity – than the US average. Therefore, as the employment share of telecommunications fell in the first period, the average level of productivity in the economy decreased. The opposite effect occurred in the second period, causing a net positive 'jump' over the two periods.

MGI analysis of the telecommunications sector relied on physical measures of output, such as the number of access lines or call minutes. This contrasts with the value-added methodology used by the BEA and in most other chapters of this report. The reason for the different approach was the availability and easy measurement of physical output, which can be compared from year to year without the need for price adjustments.[3]

In spite of the differing methodologies, BEA data and MGI analysis yield similar trends. We find higher labor productivity growth rates – almost 8 percent per year versus just over 5 percent for the BEA – but a similar pattern of acceleration (Exhibit 4). Because the results are similar, and the BEA does not publicize value-added data for individual segments of the industry, the remaining analysis in this report relies on the MGI output-based calculations.

[3] The use of output, rather than value-added, measures requires an adjustment for changes in vertical integration over time. (Otherwise, an industry that simply outsourced labor to equally productive contractors from other industries would show high productivity growth.) To account for vertical integration, MGI examined the ratio of purchased inputs to output for major firms in each part of the industry, and where appropriate adjusted the employment figures to reflect outsourced labor.

Telecom services exhibited a significant jump in IT spending. In price-adjusted terms[4], the amount of IT in the industry increased from $130,000 per worker in 1995 to $230,000 in 1999 – a growth rate of nearly 20 percent, considerably faster than the 10 percent rate of 1987-95 (Exhibit 5).

In this sector, IT investment is primarily (80 percent) in communications equipment. This includes the switching and routing equipment used to direct voice and data signals, as well as the transmission equipment that sends and receives signals across fiber optic cable and copper wire.[5] It also includes cellular base station equipment.

The telecommunications services sector provides a microcosm of the US economy, which also exhibited both a labor productivity growth jump and an increase in IT intensity.

LOCAL SERVICES

Profile of the local services subsector

This report defines local service as the transport of voice and data within a metro area over physical links (rather than through the airwaves). This includes the provision of phone and data lines to homes and businesses as well as carriage of local telephone traffic. These activities employed approximately 500,000 people and generated approximately $100 billion in revenue in 1999.

The dominant providers of local services are the incumbent local exchange carriers (ILECs): Verizon (comprising the former Bell Atlantic, NYNEX, and GTE[6]), SBC Communications (which acquired Pacific Bell and Ameritech), Bell South, and Qwest (which includes the former US West). Over 80 percent of the revenues of these firms come from voice services. Since the late 1990s, numerous competitive access providers (CAPs or CLECs – competitive local exchange carriers) have targeted specific customer segments – typically larger business customers. These new competitors represented less than 20 percent of revenues and employment in 1999. Recent CLEC financial woes have led to reduced growth forecasts and in some cases bankruptcy.

Local service is the most capital-intensive part of the telecommunications industry. Local exchange carriers maintain a staggering amount of physical plant:

[4] Figures are in 1996 dollars, based on BEA data. These 'real' figures include the effect of an MGI-estimated price index for communications equipment that shows faster price declines than the official BEA price index. The details of the MGI price index are discussed in the measurement appendix chapter of this report.

[5] Note that fiber optic cable is not included as part of IT.

[6] GTE was the only major local exchange carrier that was not one of the original “Baby Bells."

carriers reported four million miles of aerial and buried cable, more than 200 million individual access lines, and almost 20,000 central office switches to the FCC at the end of 1999. New lines or repairs often require significant construction activity as well as installation of communications equipment.

Local service is also the most heavily regulated part of the telecommunications industry. The FCC sets rates for local phone service and determines the "access charge" that long distance providers must remit to local exchange carriers for the completion of long distance calls.[7] In addition, it mandates "universal service": every US household is to receive telephone service, with poor households being subsidized by a "universal service fee" on other households. Shifts in the regulatory approach of the FCC have had a significant impact on subsequent productivity growth, altering both the competitive intensity of the industry and incentives for companies to improve profitability.

Importance of local services to the overall question

Local service contributed only 0.01 percentage points of the aggregate US productivity growth jump (Exhibit 6). This contribution was the net result of slowing productivity growth within local services (which decreased the aggregate rate of productivity growth) and a leveling off of employment (see Exhibit 7).

- Although labor productivity growth within the local service sector was positive in both periods, the average growth rate was slower from 1995 to 1999. Thus, the contribution of local services productivity growth to aggregate US productivity was smaller in the second period.

- Local service contributed positively to aggregate productivity growth because of changes in its share of total US employment. Productivity in local service is approximately 3 times the US average. Employment fell from 1987-95 but thereafter remained constant as a proportion of the US economy. Therefore, the "mix effect" from local service was negative in the former period and zero in the latter, contributing to a net change of 0.06 percent (Exhibit 8).

- IT intensity grew steadily throughout the time period studied (Exhibit 9). In real terms, IT capital per worker grew at a rate of 15 percent from 1987 to 1999. Given the fall in the productivity growth rate, this leads to the question of whether the capital might have been misapplied or underutilized.

[7] The FCC also regulates the business lines of the ILECs (for example, ILECs are forbidden from entering the equipment business and are only allowed to offer long distance services on a state-by-state basis after certain conditions have been met).

LABOR PRODUCTIVITY PERFORMANCE IN LOCAL SERVICES

By MGI's calculation, annual labor productivity growth in local service fell from nearly 8 percent in 1987-95 to approximately 5 percent from 1995-99. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI's output measure is based on a weighted index of the total number of access lines and the total number of call minutes. Input is based on the employment of all local exchange carriers (including both incumbent and competitive local exchange carriers).[8]

In spite of accelerating demand for second lines and an increase in local call minutes (used to access Internet service providers) in the late 1990s, productivity growth did not accelerate after 1995. Rising employment, due in large part to the entry of competitive access providers, ended a downward trend of employment and more than compensated for the increased output (Exhibit 10). Local services productivity growth was at its highest in the early 1990s – we explore the reasons for this in Box 1.

Box 1

EXPLANATION OF 1987-1995 LABOR PRODUCTIVITY GROWTH JUMP IN LOCAL SERVICES[9]

The productivity performance of local services in the late 1980s and early 1990s was a result of a step change in incentives for local service providers, caused by a shift from direct regulation of profits to regulation of prices (price caps) and by an increase in competition for some of the largest business customers. In our analysis of this productivity surge, we first examine changes at the firm level that contributed to increased productivity. Then, we examine what changes in industry dynamics (e.g., prices and competition) and factors external to the industry (such as regulatory or technological change) were responsible for the firm-level changes.

[8] Including local minutes as a measure of output (which is not done by the BLS/BEA) has a significant impact on measured productivity, increasing annual productivity growth in the local services segment by over 2 percent from 1995-99, and consequently increasing overall productivity growth in the telecommunications sector by approximately 1%. However, this measurement change would not affect the basic pattern of productivity growth jumps within each of the three segments. See the appendix to this chapter for more details on MGI's productivity measures, and the rationale for including local minutes.

[9] This section compares productivity growth in local services from 1987 to 1995 with the earlier period of 1981 to 1987. Although the primary focus of this report is the 1995-99 productivity growth acceleration in the US, we view other historical industry 'jumps' in productivity growth as an opportunity to learn more about the causes of, and barriers to, higher productivity. Because the highest productivity growth in local services took place before 1995, we have separated this analysis from the main body of the text.

Firm-level ("operational") factors

At the firm level productivity was driven by reducing the labor force across a variety of job types – output growth remained steady throughout the period. Some of the labor reduction was achieved through the use of IT; other reductions resulted from managerial decisions and better organization.

¶ IT enabled the elimination of numerous jobs in both back-office and customer-facing applications. Service providers and third-party vendors developed operational support systems (OSS) to automate key processes such as customer care and billing, service provisioning, and network operations. The goal of these systems was explicitly to increase "flow-through" – to eliminate the manual component of routine tasks such as taking an order for a new customer, creating a billing record, and activating service for that customer.

¶ Management decisions also increased labor productivity. In the immediate aftermath of the AT&T divestiture, the regional Bell monopolies cut back on underutilized labor. At first, this included simple actions such as pooling central office technicians (rather than assigning one person per office) and reducing the number of company business offices in smaller towns and cities.

Later, more complex reorganizations improved productivity further. For example, McKinsey estimated that a move to integrated dispatching would improve one client's field force productivity by 15 to 20 percent. The firm pooled labor both geographically (by combining different regional offices and dispatch centers) and functionally (by asking skilled technicians who were either idle, or close to an urgent job, to perform simple provisioning jobs). Performance management, which includes tracking of employee performance, coaching, and goal setting, has improved productivity between 10 to 15 percent in a variety of field force units across several companies.

Call center operations, a significant proportion of employment in all three sectors of the telecommunications industry, illustrate both IT and organizational-related productivity improvements. Advances in "self-serve" technology, such as voice response units, have reduced the human component of many customer service interactions. Other IT innovations such as automated call distributors (which route calls to available agents), computer-telephony integration (which delivers appropriate customer information to an agent's screen based on touch tones entered by the customer), and software-based scripting have greatly increased the number of calls an agent can handle in a given time. Managerial improvements such as schedule optimization and the pooling of smaller offices to reduce call volatility have helped to balance the supply of agents with demand for their services (Exhibit 11).

Industry dynamics/external factors

Improved incentives, most notably a change in government regulation, were the key drivers of change at the firm level (Exhibit 12).

- ¶ Changes in government policy altered the incentive structure for management and led to a greater push for efficiency at the firm level. The seminal event in telephone regulation was the court-ordered breakup of AT&T following years of litigation. The "Modified Final Judgment" of 1982 required AT&T to split up into a long distance and equipment manufacturing company and a set of seven local phone companies (known as the "Baby Bells").[10] The breakup took place on December 31, 1983.

  In the years of AT&T's integrated monopoly, underutilized labor existed across a number of functions. The vast organization clouded the performance of individual units, and the rate-of-return regulatory regime left little incentive for managers to reduce costs. The creation of seven independent Bell companies improved incentives somewhat, as the firms now published financial results that could be compared with each other, and were independently accountable to the financial markets.

  In the years following the breakup of AT&T, the federal government and states gradually moved to a new regulatory scheme that focused on prices. Based on financial data from the carriers, the regulator would set price ceilings (or 'caps') for local phone service. This encouraged companies to cut costs where possible, as they could now retain their profits and thus reap the benefits of greater efficiency.

- ¶ Competition for the ILECs' large business customers put pressure on prices and encouraged the incumbents to manage costs more effectively. This competition came primarily from the long distance companies, which connected large businesses directly to their networks (thus circumventing the ILEC and depriving it of revenue).[11]

These were one-time changes, which may explain the slowdown in productivity growth after 1995. By the mid-1990s, the new incentive structure had been in place for several years and managers had addressed the most obvious cases of excess labor and organizational inefficiency that were the legacy of the predivestiture era. (Exhibit 13 summarizes the 1987-95 productivity jump.)

[10] The 7 independent Bell companies were formed from groupings of AT&T's 22 regional Bell operating companies.

[11] Later, the Telecom Act of 1996 encouraged competition in local service by forcing ILECs to lease portions of their networks to new entrants. This change receives less attention here because it had no impact on the 1987-95 jump.

LOCAL SERVICES OUTLOOK, 2001-2005

MGI analysis suggests that the 1995-99 contribution of local services to aggregate US productivity growth (0.07 percentage points, including the 0.01 percentage point contribution to the 1995-99 US productivity acceleration) will be sustainable over the period to 2005.

- Output should continue to grow and in fact accelerate. Demand for local voice services should be steady or even accelerate slightly, reflecting an uptick in line growth and minutes of use over the past few years. Wider availability of data services for both business and consumer use and the consequent accelerating adoption of technologies such as DSL should increase data usage.

- Employment, however, is likely to stagnate or even fall. The dire fortunes of many competitive local carriers have led to layoffs and bankruptcies, and incumbents are likely to continue gradual productivity improvements. This will cause a negative "mix effect," as local services represent a flat or declining share of total US employment from 2001-05.

MOBILE ACCESS

Profile of the mobile access subsector

Mobile access is defined in this report as wireless voice communications.[12] This includes cellular, personal communications service (PCS), and specialized mobile radio communications for consumer and business use.

Mobile communications employed over 150,000 people in 1999, up from approximately 6,000 in 1987. (This includes employees associated with call center providers or tower management services for the mobile industry.) Total industry revenues were $40 billion in 1999.

After a long series of mergers and acquisitions to build subscriber volume and national network coverage, a few large providers dominate the cellular industry. The descendants of the original Bell companies have a strong presence in the market: Verizon has its own wireless division (a combination of the Bell Atlantic,

[12] Wireless data was an extremely small part of the overall wireless segment even in 1999, and was not included in the productivity calculations. Paging also was excluded.

GTE, and Vodafone AirTouch wireless operations), and SBC and BellSouth merged their operations to form Cingular Wireless. The long distance players also have a presence: Sprint's PCS service and AT&T Wireless (built on the acquisition of McCaw Cellular). VoiceStream has rolled up a variety of companies that operate under the GSM standard.[13] Independent player Nextel rounds out the top tier of the industry. Beyond these large players, multiple regional companies and resellers of cellular service have approximately 15 percent of the market.

Importance of mobile access to the overall question

Mobile access contributed 0.06 percentage points of the aggregate US productivity growth jump (Exhibit 14).

- ¶ Half of this acceleration was due to the increased share of mobile communications in the US economy (Exhibit 15). With almost no employment in 1987, mobile grew to 0.08 percent of US employment in 1995 and 0.17 percent in 1999 (Exhibit 16).
- ¶ The remainder of the productivity acceleration was due to productivity growth within the mobile access sector. Productivity growth accelerated from 6.9 percent in 1987-95 to 10.6 percent from 1995-99.
- ¶ Meanwhile, IT intensity rose sharply post-1995, after falling slightly over the 1987-95 period (Exhibit 17).[14] Thus, mobile communications appears to embody a “New Economy” pattern of high IT inputs and high productivity growth.

LABOR PRODUCTIVITY PERFORMANCE IN MOBILE

Mobile communications exhibits a significant jump in labor productivity growth. MGI analysis indicates that annual labor productivity gains in this segment accelerated from 6.9 percent from 1987 to 1995 to over 10 percent from 1995 to 1999. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI measured output in this segment based on the number of mobile telephone

13 Deutsche Telekom recently acquired VoiceStream.

14 Although both IT and employment grew over the 1987-95 period, employment grew more rapidly, so the IT stock per worker fell.

subscribers and the number of call minutes of those subscribers.[15] Labor was based on the total employment of wireless service providers, plus an adjustment for major categories of outsourced labor.

EXPLANATION OF 1995-1999 LABOR PRODUCTIVITY JUMP (VERSUS 1987-1995) IN MOBILE ACCESS

MGI's analysis attributes the acceleration in mobile productivity to two primary causes: the application of digital cellular equipment in the mid-1990s, and the auctioning of additional wireless spectrum to new competitors around the same time. Both changes greatly increased capacity and put pressure on prices, resulting in the rapid adoption and increased use of mobile services. We first discuss the improvement in productivity at the firm level, and then we trace these changes back to the root causes at the industry and macro level.

Firm-level factors

Mobile communications represents an example of "New Economy" IT in action. IT intensity growth jumped 20 percent per year in real terms, and this investment can be traced directly to improvements in labor productivity.

- Productivity growth was driven by rapidly rising minutes of use. (Exhibit 18). Labor grew more slowly, approximating the growth rate of the subscriber base (roughly 25 percent per year), rather than the more rapid growth in minutes of use (over 40 percent per year).
- The surge in minutes per customer was the result of significantly lower prices, often embodied in "bucket plans" that offered a set price for a specified number of minutes per month. Revenues per minute fell about 20 percent per year in 1998 and even more in 1999 (Exhibit 19). The average subscriber talked about 175 minutes per month in 1999 versus 120 in 1995, reversing a steady downward trend in usage per subscriber.
- Mobile service providers could offer lower prices because of a rapid increase in capacity in the late 1990s (Exhibit 20). Digital cellular equipment and related innovations allowed providers to leverage spectrum more effectively and thereby improve capital efficiency.

[15] These two measures were given weights based on the implied price of a calling plan with no "free" minutes – approximately $15 per month was allocated to access revenues and the remainder to usage.

Industry dynamics/external factors

In the early days of mobile telephony, the FCC allocated each major metro market two mobile licenses. The idea of the temporary duopoly was to give early investors time to recoup their capital investments, but the immediate effect was an environment of limited price competition. From 1995 to 1997 the auction of PCS spectrum (combined with the emergence of Nextel as a viable nationwide wireless player) greatly increased competition in most markets. In practice, four to five viable competitors existed in each of the major markets (Exhibit 21).

The mobile communications industry shifted from analog to digital equipment in the mid-1990s, driven in part by the new PCS competitors that installed all-digital networks. New standards for digital equipment allowed spectrum to be used more efficiently and helped companies to increase network capacity. The direct impact was on the capital productivity side, allowing wireless providers to provide more capacity with a given investment in equipment and spectrum than they could have with analog technology. However, there was also a strong indirect effect on labor productivity. The lower cost structure enabled lower prices, which stimulated greater usage of mobile phones.[16] As most labor costs were either fixed or proportional to the number of customers, the surge in usage per customer increased labor productivity. (For a summary of the drivers of the 1995-99 productivity jump in mobile, see Exhibit 22.)

As productivity growth accelerated to over 10 percent per year, the industry grew rapidly. Employment in the mobile phone industry and related services more than doubled from 1995-99, increasing the contribution of mobile services to aggregate US productivity growth.

MOBILE OUTLOOK, 2001-2005

Productivity should continue to grow rapidly in mobile communications, maintaining and even increasing the sector's contribution to aggregate productivity growth. We estimate that mobile's 0.10 percentage point contribution to aggregate US productivity growth from 1995-1999 will increase to 0.12 percentage points from 2001-05. (This assumes a similar rate of productivity growth within the sector, magnified by the sector's larger size in 2001.)

Productivity growth within the sector should remain strong for two reasons:

[16] The increased demand was due in part to other benefits of digital such as smaller, lower-cost handsets, better reception, and call services such as caller ID.

- First and foremost, voice usage should grow rapidly. This will be due both to increasing penetration of mobile and to increased usage as prices continue to fall. Industry analysts project 24 percent annual growth in minutes over the next few years to almost 500 minutes per user per month in 2004 and industry revenues of $100 billion in 2005. Even MGI's less aggressive assumptions yield high output growth.

- New services should pass into wider use as carriers upgrade networks to provide data transmission. Projections on mobile data adoption vary widely, with analysts predicting from 20 percent to 80 percent penetration among mobile users in 2004. At the time of this report it appears unlikely that data services will have a major impact on productivity growth before 2004-05.

Employment in mobile communications has grown rapidly since 1995, increasing the impact of this sector's productivity growth on the overall economy. Further employment growth, creating a positive mix effect, also appears possible (though this depends on the speed of industry consolidation). Mobile phone penetration of the US population was only about 40 percent in 1999 and remains lower than many European countries. Subscriptions and employment have continued to grow through 2001 and are likely to do so (albeit at lower rates) for the next few years. Thus, the highly productive industry is likely to become an even larger share of the economy, pulling up aggregate productivity.

LONG DISTANCE TRANSPORT

Profile of the long distance transport subsector

The long distance transport segment employed over 300,000 people in 1999, up 20 percent from 1995 due to the growth in data businesses. Overall industry revenues (net of access charges paid to local carriers) were approximately $85 billion.

In this report, long distance transport refers to the carriage of voice or data from one access provider to another. After the AT&T divestiture took effect in 1984, consumers and businesses have been able to choose which long distance provider to use. Consumers and small businesses purchase long distance service that is billed through the local access provider, while large businesses may bypass the local carrier through the use of "special access lines."

The key companies in long distance voice are the triumvirate of AT&T, WorldCom (including the former MCI), and Sprint. However, in the 1990s many new firms entered the industry. These firms fall into two major categories: backbone providers that have built entirely new networks, and telecommunications resellers, which offer service directly to consumers while leasing capacity from the major providers.

Importance of long distance transport to the overall question

Long distance contributed 0.04 percentage points of the aggregate productivity growth acceleration (Exhibit 23). This change came from productivity growth within the sector – employment in long distance remained stable as a share of the economy (Exhibits 24 and 25). Meanwhile, IT intensity grew at about 20 percent per year during the latter half of the 1990s, a jump of approximately 15 percent from the 1987-95 growth rate! (Exhibit 26).

LABOR PRODUCTIVITY PERFORMANCE IN LONG DISTANCE TRANSPORT

Based on MGI calculations, labor productivity growth rose from almost 5 percent in 1987-95 to approximately 9 percent from 1995-99. (The BEA does not publish an explicit measure of value added or employment for this subsector of the telecommunications industry.) MGI measured long distance output based on voice usage and data usage. Voice usage was measured according to a weighted index of intrastate, interstate, and international calls, and data traffic was approximated using the total bandwidth of data access lines installed on major networks. On the labor side, MGI included labor associated with the major long-distance voice companies, as well as new entrants and resellers of long distance services.

Total factor productivity (TFP) analysis shows that although labor productivity growth was high during this period, TFP growth (a measure of productivity adjusted for the level of capital investment) was actually negative. This is due to the huge capital investment, and resulting capital deepening effect, of the late 1990s investment in new backbone networks.

Labor productivity in long distance was at its highest in the early-1980s. From 1984-87, productivity growth in long distance was over 15 percent per year – higher than almost any industry except for computer and electronics manufacturing (see Box 2 for a discussion).

To understand the labor productivity jump of the late 1990s, it is instructive to divide the sector into two components: voice and data.

¶ Voice drove the productivity growth observed in the late 1990s, showing steady output growth even as labor input leveled off (Exhibit 27).

- ¶ Data showed high but fairly steady productivity growth. This was in spite of massive investments in new infrastructure.

This division is very rough, because most providers offered both voice and data services. Without detailed time-series employment data from all of the major players, it is impossible for us to allocate labor accurately between the two segments (in fact, even the total employment figure involves some approximation). It is reasonable, however, to assume that employment in data services grew over the late 1990s, and under our estimate of flat employment for the long distance industry as a whole, this implies a drop in voice employment.

EXPLANATION OF 1995-1999 PRODUCTIVITY GROWTH JUMP IN LONG DISTANCE VOICE

The productivity jump in long distance voice was really a return to earlier high rates of productivity growth after depressed performance in the mid-1990s. A rapid buildup of marketing and customer service personnel for voice and data services helps explain the 1987-95 productivity slowdown.

Firm-level factors

A range of improvements in call center and back office productivity (refer back to Exhibit 11 for examples) occurred in the late 1980s and 1990s. While it was impossible to determine the exact productivity improvement from each, there is no question that IT enabled many productivity gains. For example, computer-telephony integration allowed customer service agents to pull up customer records more quickly, saving agent time, while voice recognition software enabled a higher proportion of customers to use self-service features, reducing the labor required to answer 411 inquiries. However, though IT clearly contributed to ongoing productivity *growth*, interviewees did not cite IT as a source of productivity *acceleration* over the late 1990s.

One cause of the late 1990s improvement in productivity growth may have been a slowdown in the marketing race between the big long distance voice providers. In the early 1990s, this competitive dynamic led to higher marketing expenditures (e.g. increased outbound call center staffing and equipment, more advertising) to capture residential and small business customers (Exhibit 28), and increasing industry employment.[17]

[17] Part of the increase in employment during this period is attributable to the buildup of organizations to operate and sell data services, primarily to large business customers.

Industry dynamics /external factors

The nature of competition in long distance changed considerably during the mid to late 1980s. With the breakup of AT&T, opportunities for new long distance providers to interconnect with the Bells stimulated a flood of new entrants. Rapid price declines followed and an industry shakeout left a few dominant players – AT&T, Sprint, LDDS, and MCI (the latter two companies now part of WorldCom). From 1987 to 1995 this oligopolistic industry structure was fairly stable, though the three smaller companies were gaining share at the expense of AT&T. All of the companies rapidly increased their investment in marketing activities, instituting outbound calling programs and minting dozens of different calling plans. The surge in marketing activity dampened labor productivity growth between 1987-95, but abated somewhat in the late 1990s.

(Please see Exhibit 29 for an overall summary of the 1995-99 productivity growth jump in long distance.)

EXPLANATION FOR LACK OF 1995-1999 PRODUCTIVITY GROWTH JUMP IN DATA

Communications equipment for new long distance data networks represented the vast majority of IT spending in this period.

Firm-level contribution of IT spending to productivity

In the late 1990s, several new nationwide networks were built in anticipation of a rapidly growing market for enterprise data transport (Exhibit 30). The availability of new equipment with stunning performance characteristics, combined with a "land grab" attitude towards market share (i.e., the notion of first mover advantage, combined with the awareness of competitors angling for the same customer base), prompted financiers and management alike to build capacity rapidly.

Although demand for data services is growing quickly, the current capacity utilization of these networks is very low – so low that the financial viability of several companies is in doubt. While the currently lit networks will eventually fill up, it is clear that excess capacity exists for the short to medium term.

One of several reasons for the disappointing performance of data backbone providers has been slow broadband adoption by consumers and small businesses. Broadband adoption in the US was well under 5 percent at the end of 1999. Complications with the rollout of many competitive local service providers, slowed further by sluggish deployment and resistance from the major incumbents, retarded the growth of this market.

Industry dynamics/external factors contributing to IT spending

Technological innovation was the most important cause of the boom in long-haul network investment. It affected the potential supply of, as well as the demand for, data services.

- On the supply side, technological breakthroughs enabled higher capacity networks. A revolution in optical technologies vastly increased the amount of data that could be transmitted over a single fiber optic strand.
- On the demand side, the growth of the Internet and projected exponential increases in demand for data transport created a big market opportunity.

These technological changes, mixed with a booming capital market, created ideal conditions for excessive investment in the sector. While growth in data demand has been healthy, the networks of these new firms are still very underutilized. (See Exhibit 31 for an overall summary of factors explaining the unproductive IT investments.) Industry consolidation is almost certain.

LONG DISTANCE OUTLOOK, 2001-2005

MGI expects the long distance segment to contribute even more to US aggregate productivity growth (0.11 percentage points) over the next few years than it did in the late 1990s (0.10 percentage points).

The long distance transport segment is likely to exhibit high productivity growth – likely over 10 percent annually – in the coming years. Industry players already have invested an enormous amount in both capacity and in the sales/marketing resources needed to fill that capacity. Additional data volume should be quite scalable, with proportionately less labor required. In fact, the industry is likely to consolidate to cope with rapid price drops for most services.

- Output growth should be very rapid. Long distance voice output rose 8 percent per year in the 1990s. Near-term performance should be comparable or better, given significant price drops in 1999-2000 and beyond. (Recent price cuts have been driven in part by the aggressive entry of ILECs, as regulators allow the formerly restricted monopolies to sell long distance services.) On the data side, a McKinsey/ J.P. Morgan securities study has estimated data traffic growth of up to 60 percent over the next few years, though data revenues will grow much more slowly due to falling prices.
- Employment should be relatively flat, in line with recent years, or perhaps even decline as the industry consolidates.

Box 2

THE 1984-1987 PRODUCTIVITY GROWTH JUMP IN LONG DISTANCE

In the mid-1980s, the long distance industry experienced a remarkable surge in productivity growth. For a short time, output increased between 15 and 20 percent per year while employment fell. This period is an example of the power of regulation – in this case the breakup of the AT&T monopoly – to affect productivity.

Firm-level factors

Before 1984, annual growth in long distance minutes hovered at 6 to 7 percent. Aggressive marketing by new entrants, together with falling prices, more than doubled this growth rate in 1984 and 1985 (Exhibit 32).

Meanwhile, the newly independent long distance business of AT&T, saddled with much of the workforce of its integrated predecessor, aggressively reduced employment. In the 5 years following divestiture, the firm cut over 50,000 workers from its payroll through attrition and layoffs (Exhibit 33). As AT&T represented the vast majority of employment in the long distance industry at this time, the cuts had a large impact on industry labor productivity. These cuts were a combination of excess labor from the monopoly years and a more aggressive application of organizational improvements and IT solutions.

Industry dynamics

The growth of real competition in the long distance market was responsible both for the increased demand and for the cost-cutting measures by AT&T. MCI, LDDS, and Sprint emerged from a group of new players to provide a serious challenge to the former monopoly. Prices dropped approximately 20 percent between 1984 and 1987, stimulating greater call volume by consumers and businesses.

External factors

The long distance competition was in turn the result of legal and regulatory support. Legal battles marked the introduction of long distance competition in the 1970s, and eventually led to the Department of Justice antitrust suit against AT&T. The breakup of the company changed the game for AT&T and its competitors. The new local phone companies were eager to see long distance competition, and FCC rules helped emerging companies to interconnect at favorable rates, giving the young industry a boost.

APPENDIX – DETAIL ON PRODUCTIVITY MEASUREMENT METHODOLOGY

This section elaborates on the data and measurements MGI used in its productivity calculations, and compares MGI's analysis with the results of productivity calculations based on BEA data (Exhibit A1).

Local service

For local service, MGI's output measure is a Fisher quantity index of the number of local access lines and the total number of call minutes.[18] For the number of access lines, MGI used local loop data from the National Exchange Carrier Association. This series has an almost identical trend to the FCC's access line figures and was available back to 1981. MGI estimated call minutes as one-half of all "dial equipment minutes" as measured by the National Exchange Carrier Association, plus one-half the total volume of international calls.[19] Long distance call minutes are included in this measure because they originate and terminate with local carriers.[20]

Ideally, the output measure would include call services – both operator-assisted calls such as 411 and software-driven services such as call waiting and conference calling. Unfortunately, reliable data for these services were not available over long periods of time. Given that call services account for no more than 15 to 20 percent of industry revenue, sensitivity analysis with the data available suggests that the influence might have been on the order of magnitude of 1 percent productivity improvement over the two periods, possibly with a greater impact on the second period. Therefore, inclusion of call services would not have altered the basic pattern of productivity growth in each segment.

Price indices for access lines and minutes are determined implicitly, based on total local service and network access revenue figures from the FCC's *Statistics of Common Carriers* publication (Table 4.2). Local service revenue is split among access lines and minutes on an equal basis, while access revenues are attributed wholly to call minutes. The logic here is that access revenues are a variable

[18] The measure of call minutes is based on one-half of all dial equipment minutes as reported by the FCC, plus an estimate of one-half of international call volume. Long distance calls are included in this measure, because local switching and termination is essential to the completion of these calls. (Exception: calls that terminate in special access lines, which are handled separately.) For interstate calls, terminating access minute data was used because experts interviewed by MGI felt this data more accurately portrayed total call minutes.

[19] Note that the scaling factor of one-half does not affect the calculations, but simply converts equipment minutes to conversation minutes. This is an approximation, as equipment minutes (which are really switch minutes) do not translate to conversation minutes in a perfect 2:1 ratio. Some calls can pass through tandem switches, which would increase the count. Others might originate or terminate on special access (dedicated) lines, which would decrease the count. To compensate for this bias, MGI deals with special access lines separately.

[20] Except in the case of special access lines (as explained in the previous footnote) or international calls.

charge related directly to the number of (long distance) call minutes. Although most residences do not pay per-minute charges for local calls, businesses (and consumers in some states) do pay incremental charges for switched local calls.

Input is based on the employment of all local exchange carriers (including both incumbent and competitive local exchange carriers).[21] Employment for LECs comes from *Statistics of Common Carriers* data on ILECs employment, with a small adjustment upward (of approximately 8 percent in each year) to reflect employment in small LECs. CLEC employment is estimated using data from the Strategis Group and a review of SEC filings for many of the larger CLECs. Because the goal of the study was to measure operational labor productivity, MGI subtracted an estimate of the number of workers involved in capital-forming (investment) activities – principally network construction and new line provisioning. This adjustment had little impact, increasing annual employment growth by 0.1 percent from 1987 to 1995 and reducing it by 0.3 percent from 1995 to 1999.

Note that local access does not include all employment from Internet-related businesses, such as Internet Service Providers (ISPs) or on-line content/commerce businesses. These firms provide services that use the telephone network, but do not provide the connectivity itself. Inclusion of ISP accounts and ISP employment would have little effect in the first period (because employment and revenues were very small as a proportion of local service or the telcom industry as a whole). In the 1995-99 period, inclusion of consumer ISP employment would have decreased productivity growth by approximately 0.5 percent to 1 percent. (A significant fraction of business ISP employment was included in the long distance segment by default – e.g., UUNet, a subsidiary of WorldCom, is the largest business ISP.)

Mobile access

MGI measured mobile output in this segment based on a Fisher quantity index of the number of mobile telephone subscribers and the number of mobile call minutes. The source for the quantity data was the Cellular Telephone Industry Association's (CTIA's) *Wireless Industry Indices* report. MGI calculated prices (needed to construct the Fisher index) from the CTIA's industry revenue figures. Based on a review of recent “bucket” calling plans from mobile service providers, 30 percent of revenue was considered access revenue and the remaining 70 percent usage (call minute) revenue. (The two measures were given weights based on the implied price of a calling plan with no free minutes – approximately $15 per

[21] An adjustment is made to remove installation (capital-forming) labor from the employment pool. Without such an adjustment, labor productivity would be reduced in years where the industry is growing quickly, even if nothing had changed in the underlying provision of service. Capitalized investment is incorporated into the calculations of TFP later in the discussion.

month.) Thus changes in the number of call minutes influenced productivity growth more strongly than changes in the number of subscribers – though both figures have grown rapidly since the beginning of the cellular era.

Input data for mobile productivity (e.g., employment) also came from the CTIA. This data was adjusted upward to account for three major components of outsourced labor – call center providers (such as Convergys and West), tower management companies (such as American Tower), and billing providers. This adjustment accelerates employment growth (and therefore reduces estimated productivity growth) in the first period by almost 3 percent but has a smaller effect on the second period.

Long distance

MGI measured long distance output based on voice usage and data usage. Voice usage was measured according to a Fisher quantity index of intrastate, interstate, and international calls. Quantity data for intrastate and interstate calls came from the National Exchange Carrier Association. The source for international call data, as well as revenue data for all types of calls, was the FCC publication *Statistics of the Long Distance Communications Industry*.

To get an accurate estimate of employment for long distance carriers, MGI employed a bottom-up approach. First, MGI estimated the employment of the three largest carriers using annual report and Compustat data, adjusting where possible for nonrelevant subsidiaries (e.g., an estimate of employees in AT&T's equipment subsidiary – now Lucent Technologies – was subtracted from early AT&T data). Employment for the eight largest competitive/emerging carriers was based on publicly available data and was adjusted upward to include second-tier and metro area carriers. A similar method was used to estimate the employment of long distance resellers.

Reconciliation with BEA data

The Bureau of Economic Analysis is the principal source of MGI's aggregate economic data. Because the BEA constructs value-added industry statistics that sum to total GDP for the economy, comparison with its figures is useful to gain an understanding of the impact of a given sector on the overall economy.

For the overall communications sector, the BEA uses the Census definition of communications (Standard Industrial Classification 48). The BEA then divides communications into two subsectors: "telephone and telegraph" (SIC codes 481, 482, and 489) and "radio and television" (SIC codes 483 and 484).

MGI's industry definition corresponds closely to SIC 481, which accounted for almost all of the value added in the telephone and telegraph sector.[22] Both the BEA and MGI industry definitions include local voice and data traffic, long distance voice and data traffic, and mobile voice communications. Note that the Bureau of Labor Statistics also uses SIC 481 for its "Telephone Communications" category.

MGI calculated labor productivity growth in two ways:

¶ First was a simple calculation of value-added per worker using data from the BEA.[23] This value-added data is the same data that BEA uses to construct overall GDP for the US economy and yields a compound annual labor productivity growth rate of 5.0 percent from 1987 to 1995, rising slightly to 5.2 percent from 1995 to 1999.

¶ MGI arrived at higher productivity growth rates through an alternative productivity analysis: a calculation of output units per worker. Because telecommunications output consists of simple, measurable, fairly well defined quantities (such as access lines and call minutes), it is possible to construct a quantity index of output. The quantity index is then divided by a measure of the labor required to produce that output. Because output is being measured, rather than value added, labor must be adjusted for changes in the proportions of outsourcing and of capital-producing labor (e.g., construction).[24] This quantity analysis yielded a productivity growth rate of 7.5 percent per annum from 1987-95 and 7.8 percent from 1995-99.

MGI labor productivity calculations for the telecom sector as a whole differ from calculations using BEA data for two principal reasons:

¶ First and most important, the output measures differ. BEA measures value added, while MGI uses output quantities. The BEA's calculation of value added is a sum of labor compensation, profits, and several other variables. Real (price-adjusted) value added is derived based on price

[22] SIC 481 accounts for more than 96 percent of value added in "telephone and telegraph" for every year from 1989 to 1998. (1999 data was not available at this level of detail at the time of this analysis.) SIC code 482 represents telegraph communications and 489 represents "communications services not elsewhere classified." Within SIC code 481 MGI does not include paging (approximately 2 percent of communications revenues in 1999) or directory advertising (less than 1 percent of industry output in 1999).

[23] BEA does not publish its own productivity calculations. MGI used BEA data on value added for the telephone and telegraph sector and divided this by "persons engaged in production" (PEP) for the sector.

[24] Without an adjustment for outsourcing, any move toward outsourcing would automatically increase productivity since labor would fall and output would not change. Likewise, including labor that is focused on capital formation (such as construction of new networks) would unduly penalize industry productivity, since it is not directly involved in the delivery of telecom services.

series for all of the various outputs involved, which are provided by or derived from Producer Price Indices from the Bureau of Labor Statistics. The trends in 'real' value added derived from industry revenues and these price indices differ in several cases from the trends in MGI's quantity measures.

- Local service output differs because MGI includes local minutes in its measure of output. Although many users do not incur any marginal cost for additional local minutes, they do represent an output of the industry and a value-added utilization of the network. The inclusion of local minutes increases overall measured productivity in telecommunications by 0.1 percent between 1987-95 and 1.3 percent between 1995-99.

- Long distance price indices for MGI show a much more significant drop in the late 1980s in comparison with the BLS. Thereafter the implied MGI prices and the Bureau of Labor Statistics “Toll Service” price index follow a similar trend. This discrepancy increases MGI productivity growth by 0.8 percent between 1987-95 and 0.2 percent between 1995-99 vis-à-vis the BEA data. This difference occurs because MGI uses terminating access minutes data for interstate calls, rather than NECA data on dial equipment minutes, which appears to be the source for the BEA.

- Mobile output varies as well. The BEA uses the PCE (personal consumption expenditure) series for wireless communications to deflate wireless industry revenues. MGI quantity measures imply a much steeper drop in prices in the late 1990s, which appears to be borne out by aggregate revenue and minutes data. One reason for the difference could be that MGI prices are implicitly based on minutes used, rather than minutes purchased (because of the popularity of fixed-cost bucket plans which provide a set number of minutes, these two measures can vary). MGI and BEA price trends basically agree from 1987-95, but MGI's drop is much greater from 1995-99, accounting for an additional 1.3 percent of the sector's labor productivity growth.

- MGI also adds detail on data communications and private lines. The BEA also incorporates a datacom measure, although the exact measurement used is unclear. The likely difference here is the use of delivered bandwidth (the number of access lines multiplied by the bandwidth of each) as a measure for the output of long distance data communications. The rationale for this measure is that the bandwidth of business special access lines attached to the telecommunications backbone is a reasonable proxy for the data traffic traveling over that backbone. (At any rate, it may be the best estimate available publicly.) In comparison with the number of special access lines, unweighted by bandwidth, this measure increases productivity growth by 0.4 percent between 1987-95 and 2.0 percent between 1995-99. The sources for this information are the FCC and IDC.

¶ Second is the discrepancy between the BEA's real value added and real output measures. This involves an adjustment of both the numerator (value added or output) and the denominator (employment) in the productivity equation. The numerator was adjusted from BEA's deflated value added time series to BEA's deflated output time series. To make the BEA data comparable with MGI's analysis on the input side, we replaced BEA employee series with the MGI calculation of employment. (BEA calculates a “persons employed in production” measure, which includes both full- and part-time labor. MGI built a telecommunications sector employment series using a bottom-up approach, and incorporated significant chunks of labor outsourced to companies in other SIC codes. MGI also made an adjustment to remove workers involved in capital-forming activities.[25]) The net effect of the shift to an output measure with the MGI labor input data is increased labor productivity growth by 0.6 percent per year in the first period and by 1.8 percent in the second period.

¶ Several smaller differences account for the remaining discrepancy between MGI results and the BEA data. For example, the MGI industry definition is slightly different (as discussed above). In this chapter, references to the telecommunications sector refer to the MGI industry definition and productivity measures, unless otherwise noted.

[25] In the late 1990s, demand for second telephone lines and new data services such as DSL led local telephone companies and upstart competitors to hire installation technicians in much higher numbers. Because these personnel were involved in investment rather than operational activities, they have been excluded from the employment figures for the labor productivity calculations.

CONFIDENTIAL

Productivity in the Telecommunications Services Sector

McKINSEY GLOBAL INSTITUTE

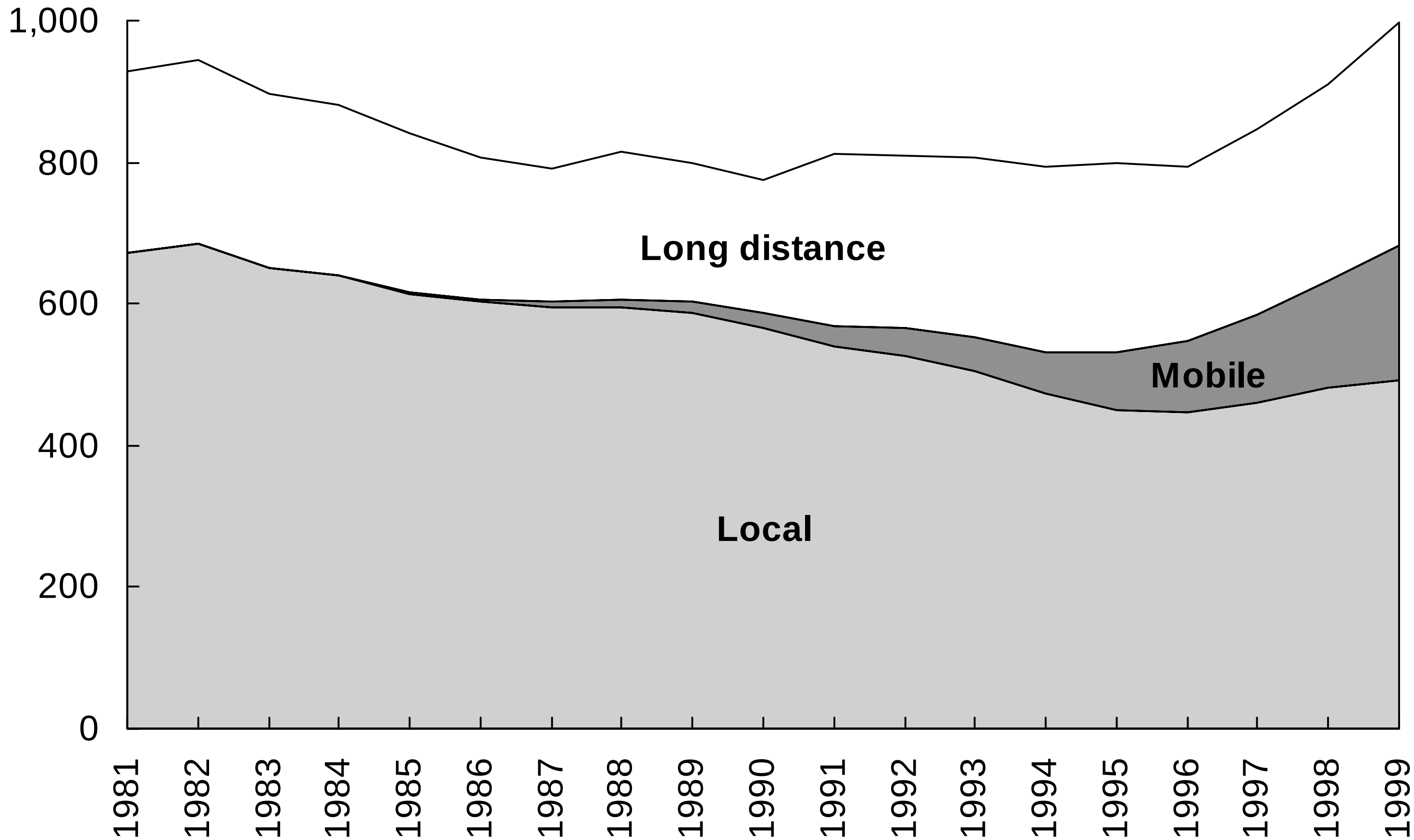
Exhibits to Accompany Telecom Services Case Study

October 7, 2001

Exhibit 1

OVERALL TELECOMMUNICATIONS INDUSTRY EMPLOYMENT WAS FAIRLY STABLE, THOUGH ITS COMPOSITION CHANGED

Thousands of employees



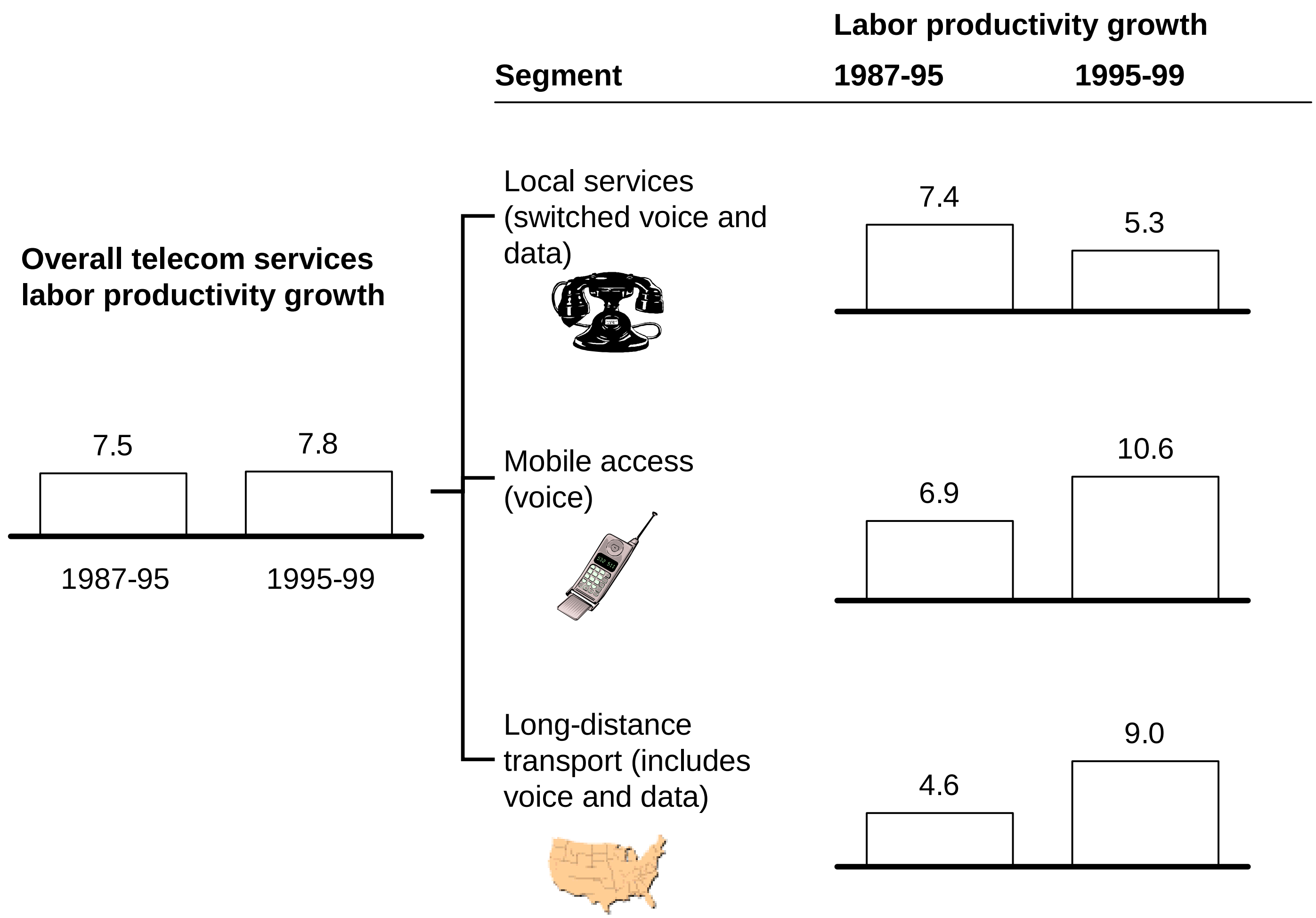
Note: The local and mobile segments include estimates for outsourced call center, billing, and tower management labor. Local services is net of estimate of capitalized labor (line installation workers)

Source: BEA, FCC, Cellular Telecommunications and Internet Association, Compustat, Census Bureau, MGI analysis

Exhibit 2

LABOR PRODUCTIVITY GROWTH VARIES BY SEGMENT

Compound annual growth rates

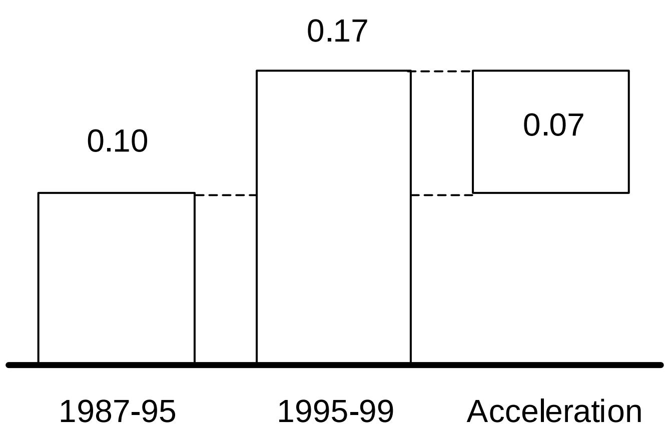


Source: FCC, CTIA, BLS, Compustat, MGI analysis

Exhibit 3

TELECOM SERVICES CONTRIBUTED TO THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, BEA data



- Telecom services represents approximately one-twentieth (0.07%) of the total US productivity growth jump of 1.33%
- Telecom services ranks sixth among the 59 BEA private sector categories in terms of the size of its jump*

* Not including the "holding and investment offices" (due to statistical anomalies) or farms sectors

Source: BEA, MGI analysis

Exhibit 4

MGI ANALYSIS IS BROADLY CONSISTENT WITH BEA DATA

Compound annual growth rates

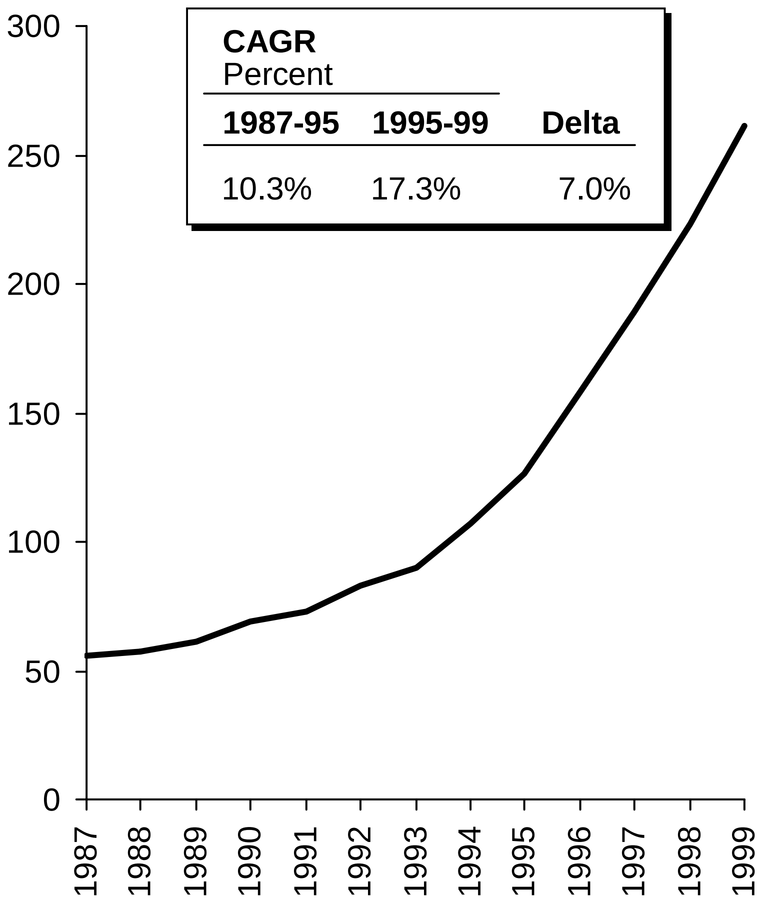
Source: BEA, FCC, CTIA, Dataquest, MGI analysis

Exhibit 5

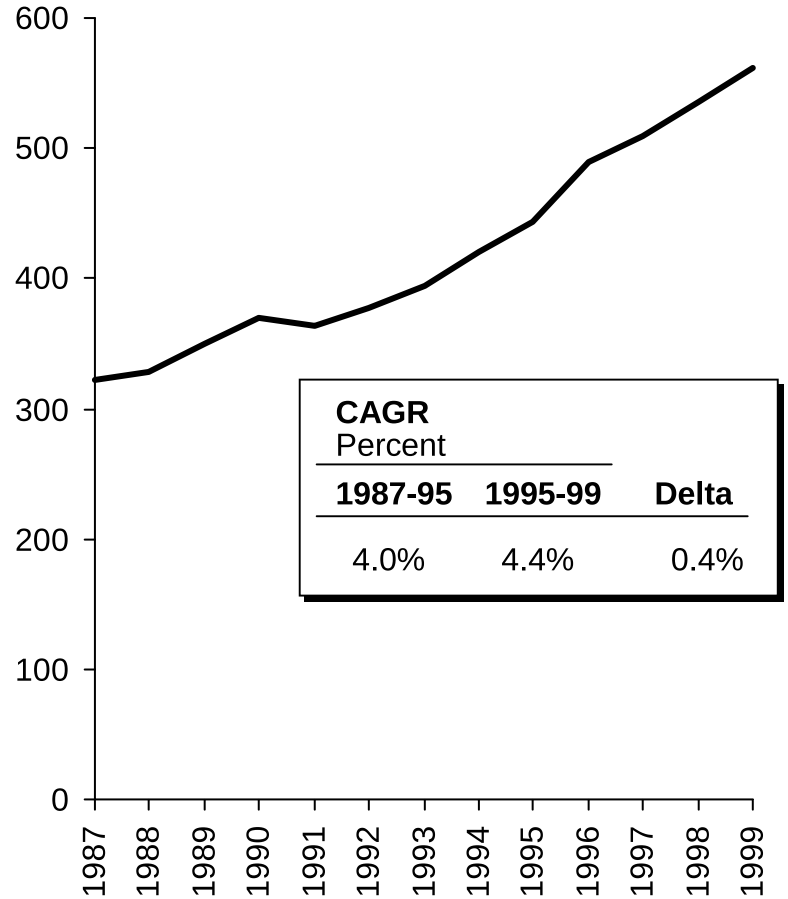
IT AND TOTAL CAPITAL INTENSITY GROWTH ACCELERATED

Thousands of 1996 dollars per employee

IT capital intensity*



Total capital intensity



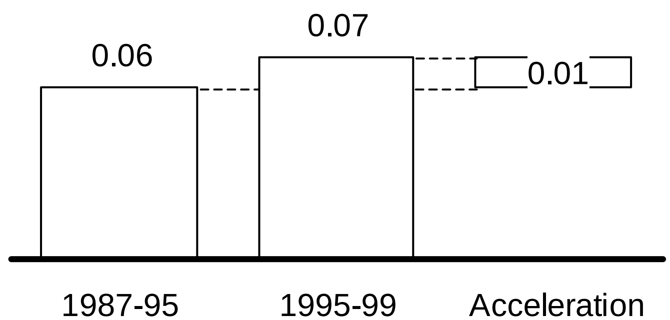
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications services sector)

Source: BEA, MGI analysis

Exhibit 6

LOCAL SERVICES CONTRIBUTED LITTLE TO THE US LABOR PRODUCTIVITY GROWTH JUMP

Contribution of local services to aggregate productivity growth
CAGR, MGI analysis

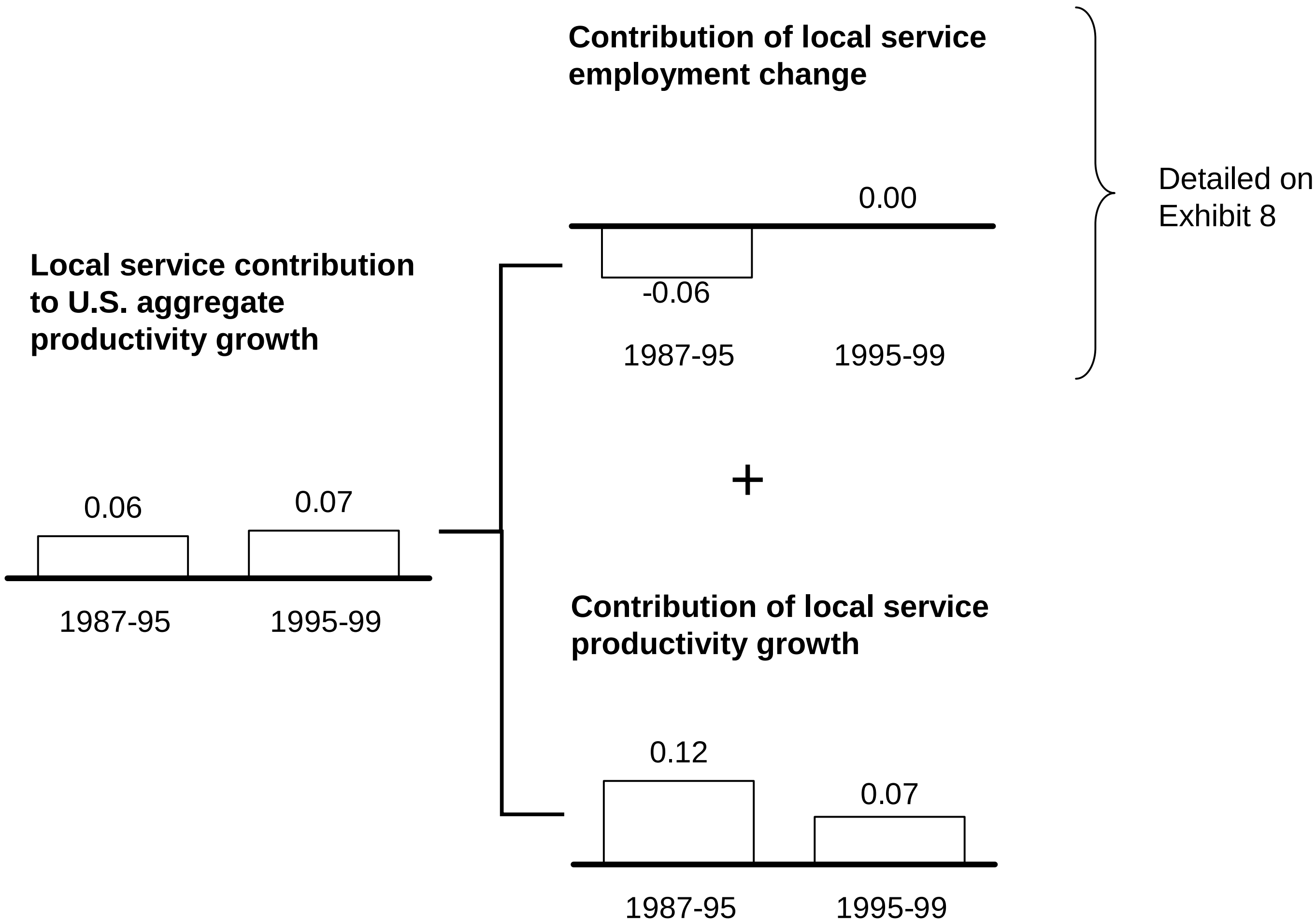


Source: BEA, MGI analysis

Exhibit 7

LOCAL SERVICE CONTRIBUTED LITTLE TO THE AGGREGATE JUMP BECAUSE ITS PRODUCTIVITY GROWTH RATE FELL

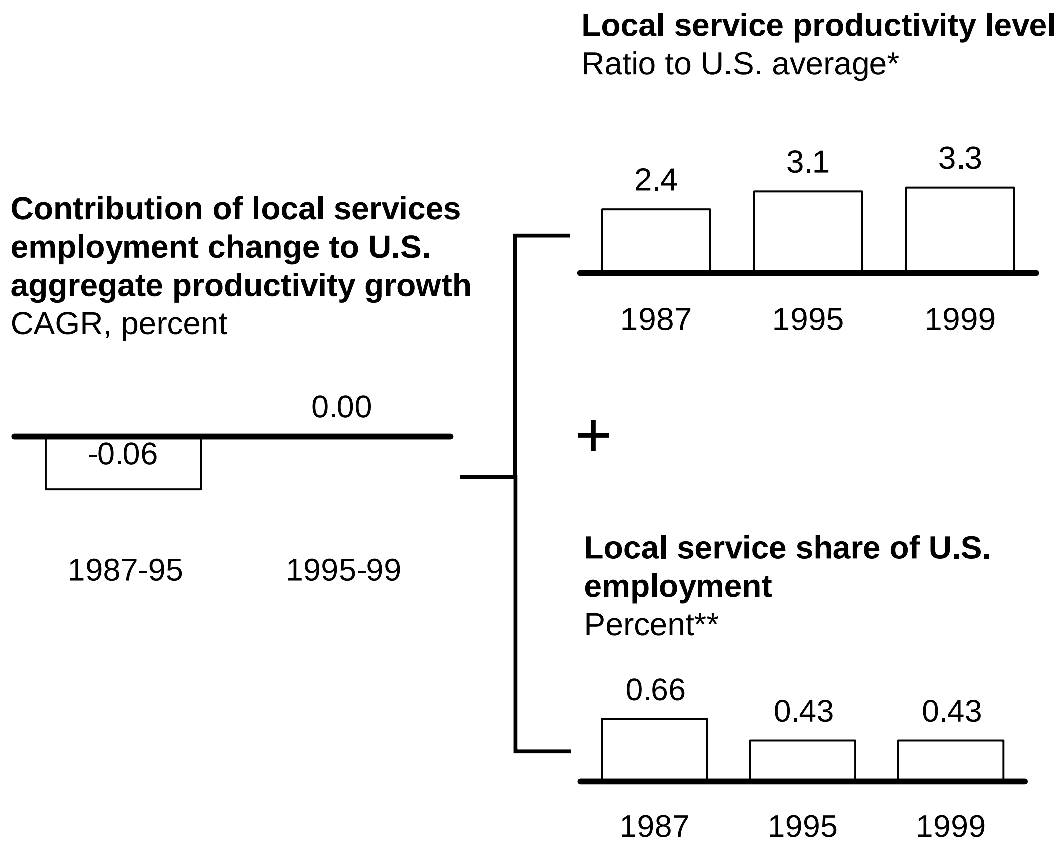
Compound annual growth rates



Source: BEA, MGI analysis

Exhibit 8

LOCAL SERVICES EMPLOYMENT FELL AS A SHARE OF THE ECONOMY IN THE 1987-95 PERIOD, AND REMAINED CONSTANT THEREAFTER



* This calculation is an approximation based on the 1987 total BEA value added for the "telephone and telegraph" sector and splitting this figure among local services, mobile access, and long distance based on the revenues of each segment

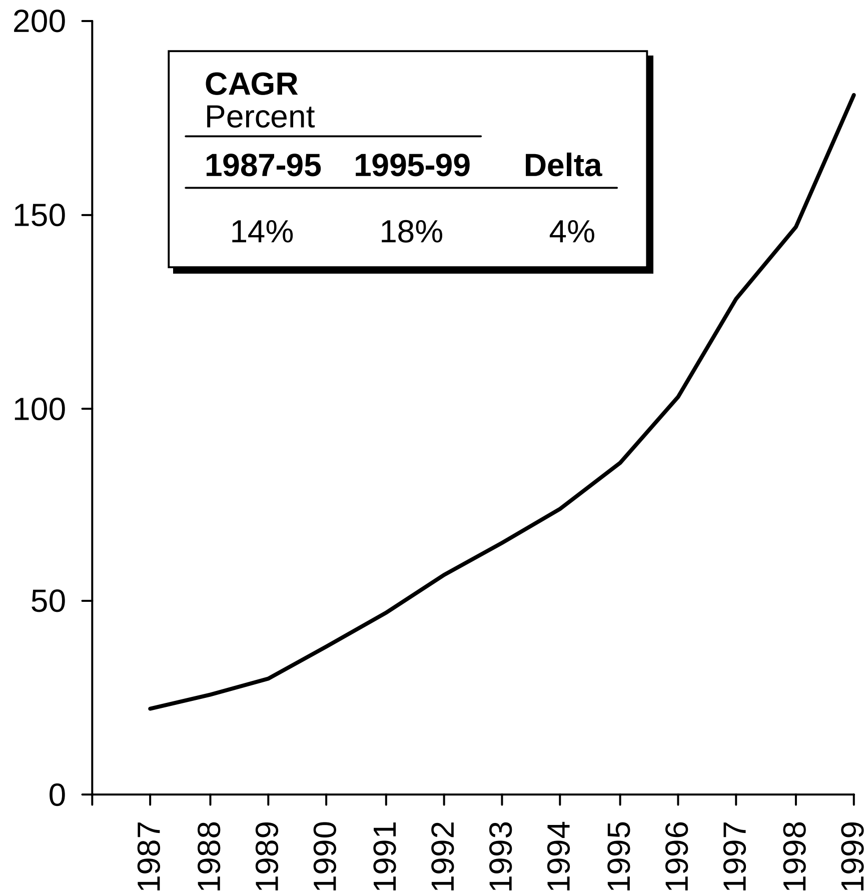
** Share of private-sector employment

Source: BEA, MGI analysis

Exhibit 9

IT INTENSITY GROWTH IN LOCAL SERVICES WAS RAPID

IT capital intensity in local services, thousands of 1996 dollars per employee



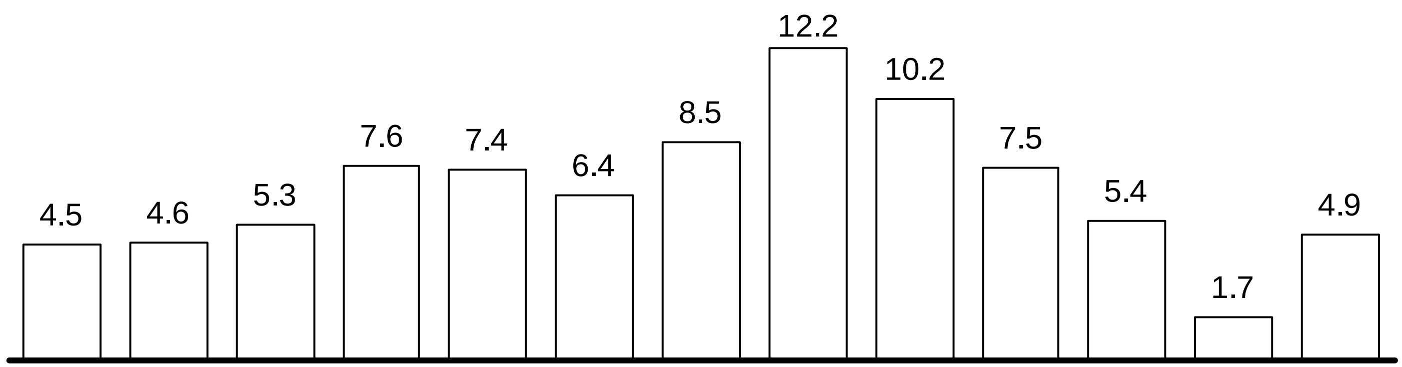
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

Source: BEA, FCC, CTIA, Hoovers, Compustat, MGI analysis

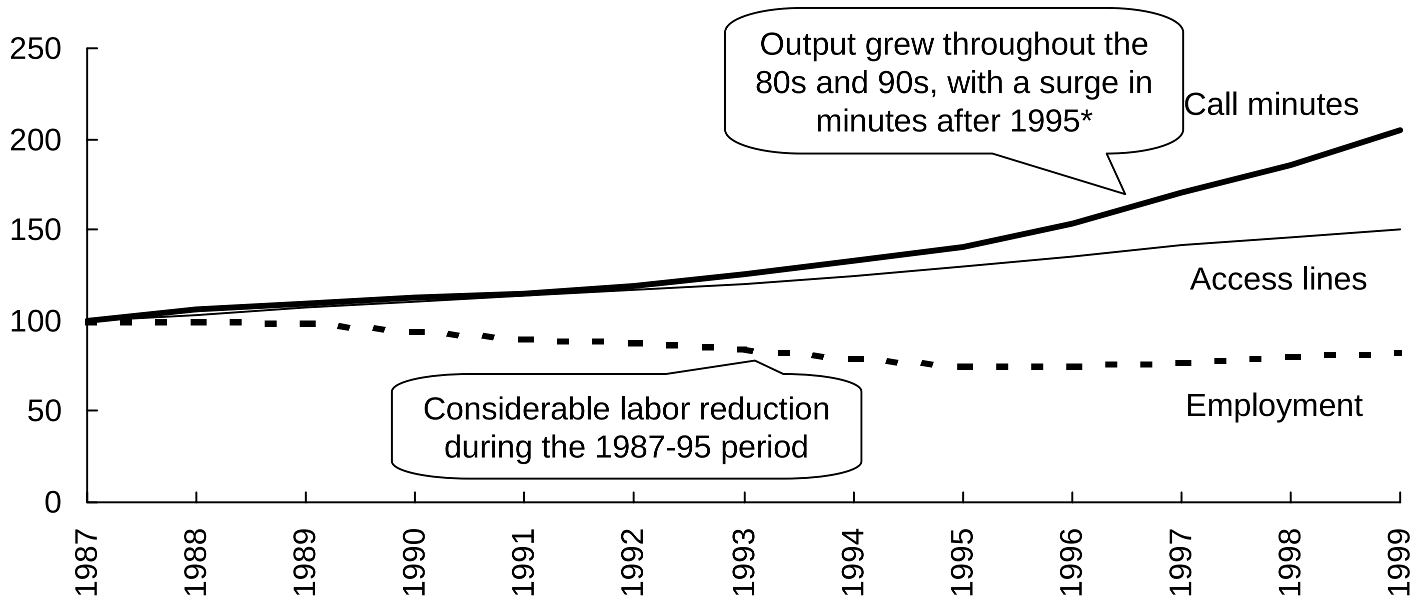
Exhibit 10

PRODUCTIVITY IN LOCAL SERVICE WAS HIGHEST IN THE EARLY 1990s

Local service annual productivity growth
Percent



Local service output and input measures
Index, 1987=100



* The surge in minutes was caused by the use of voice lines for dial-up Internet access

Source: FCC, MGI analysis

Exhibit 11

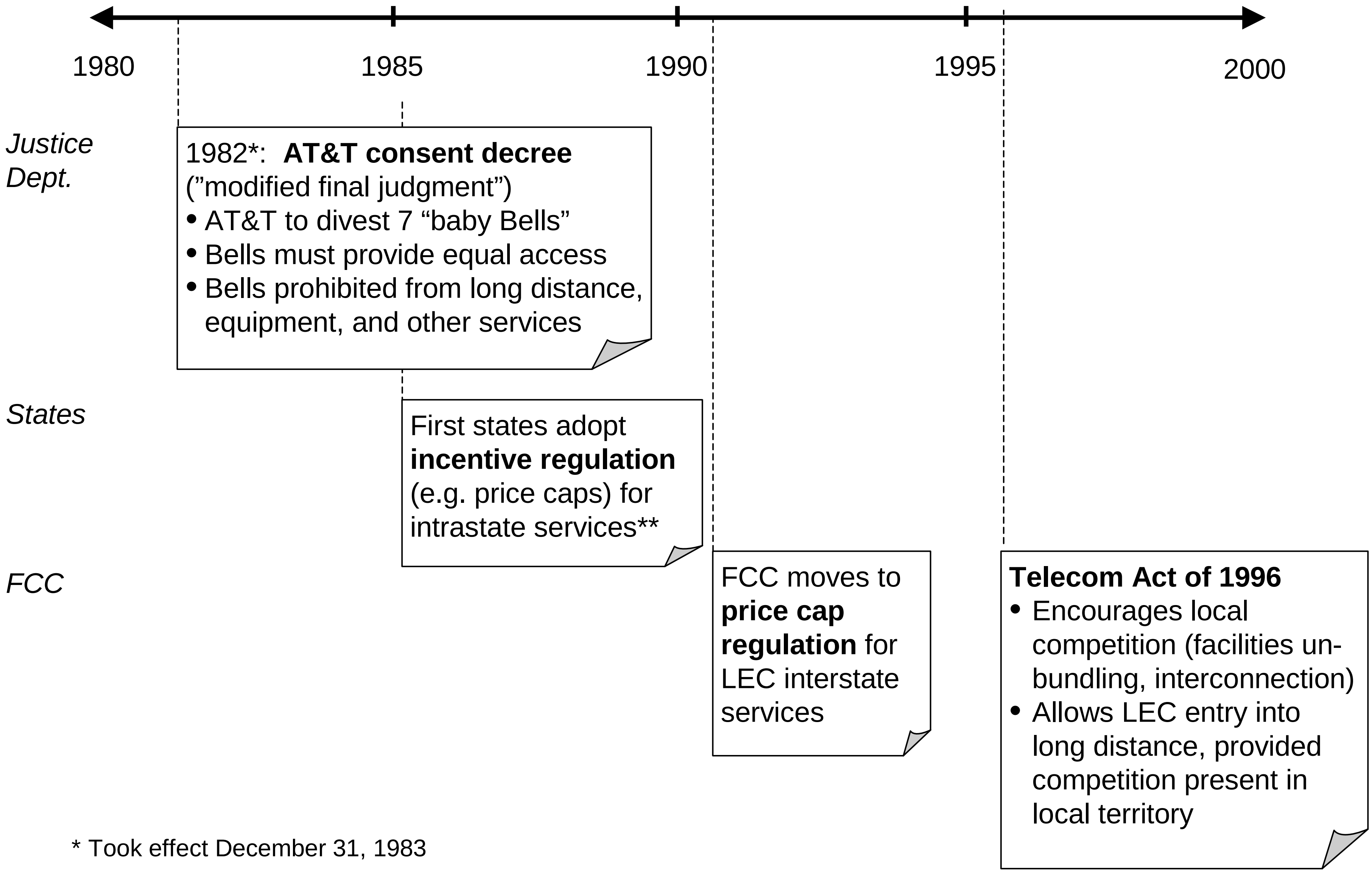
CALL CENTER PRODUCTIVITY HAS IMPROVED, LARGELY DUE TO THE APPLICATION OF NEW TECHNOLOGY

	Key changes	Examples of impact
Technology	• Move to customer "self service" – Voice recognition/synthesis – Use and effective design of automated response systems (VRUs) • Automation support for call center agents – Automated call routing/distribution – Computer-telephony integration – Scripting and databases	• Growth in call center agents has been at or lower than the growth rate of industry output • At the same time, call center agents have taken on greater responsibilities – Outbound marketing campaigns to attract competitors' customers (long distance) – Upselling new services or calling plans to inbound callers – Improvement in customer service metrics/satisfaction
Organization	• Performance management and tracking, incentives • Capacity planning/linking of multiple centers to spread calls more efficiently (better matching of workforce to call volume)	

Source: Datamonitor, expert interviews

Exhibit 12

SEVERAL REGULATORY EVENTS AFFECTED LOCAL SERVICES PRODUCTIVITY



* Took effect December 31, 1983

** Adoption of incentive regulation by states continued into the 1990s

Source: *The Law and Regulation of Telecommunications Carriers* (Brands and Leo), FCC

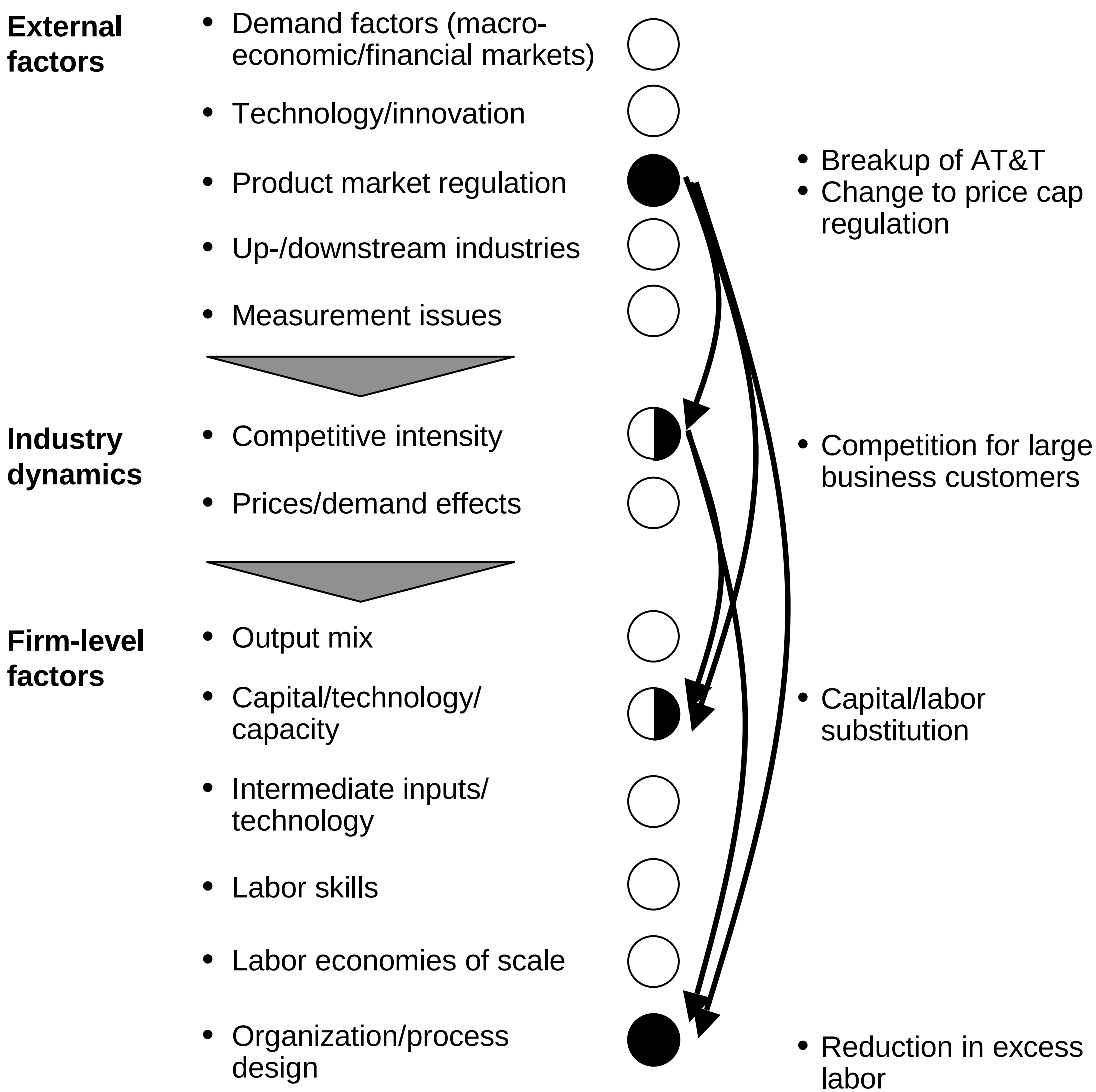
Exhibit 13

REGULATORY CHANGE WAS THE KEY DRIVER OF THE 1987-95 JUMP IN LOCAL SERVICE PRODUCTIVITY

Important
(>50% of acceleration)

Somewhat important
(10-50% of acceleration)

Not important
(<10% of acceleration)

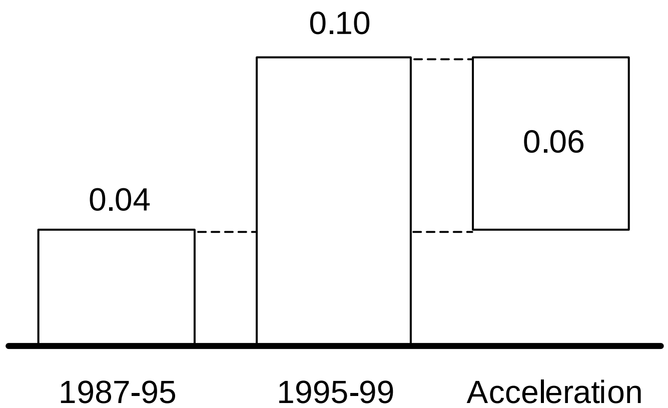


Source: Interviews, MGI analysis

Exhibit 14

MOBILE COMMUNICATIONS WAS A SIGNIFICANT COMPONENT OF THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, MGI analysis



- Mobile access had the largest productivity contribution of the three telecom services subsectors
- On a standalone basis, mobile would rank as the sector with the ninth highest contribution to aggregate US productivity growth jump*

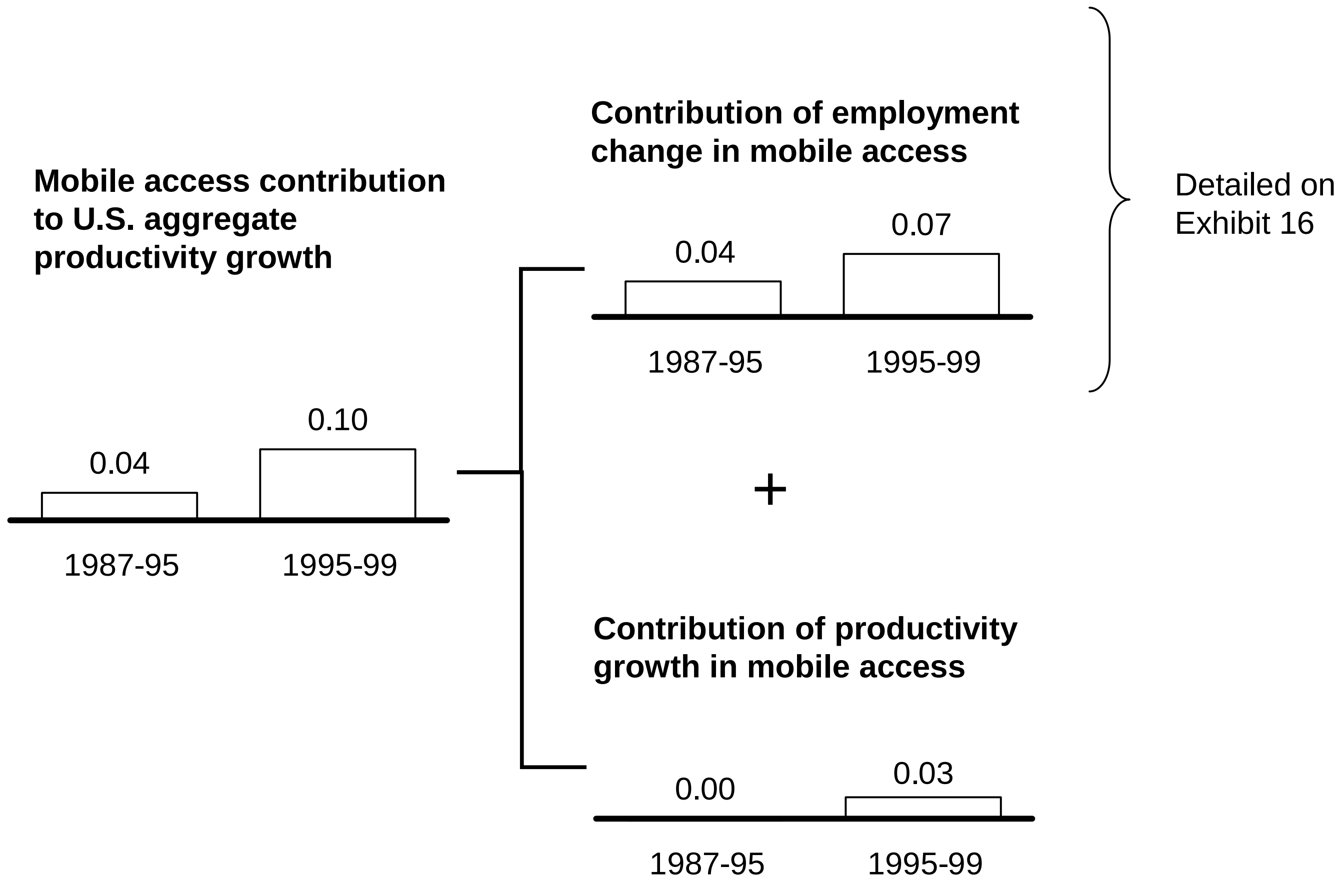
* After the five other MGI "jumping sectors", plus farms, health services, and real estate. Does not include contribution of "holdings and investment offices" because that sector's high contribution is due to statistical irregularities.

Source: BEA, MGI analysis

Exhibit 15

MOBILE CONTRIBUTED TO THE AGGREGATE US PRODUCTIVITY JUMP THROUGH BOTH EMPLOYMENT GROWTH AND PRODUCTIVITY ACCELERATION

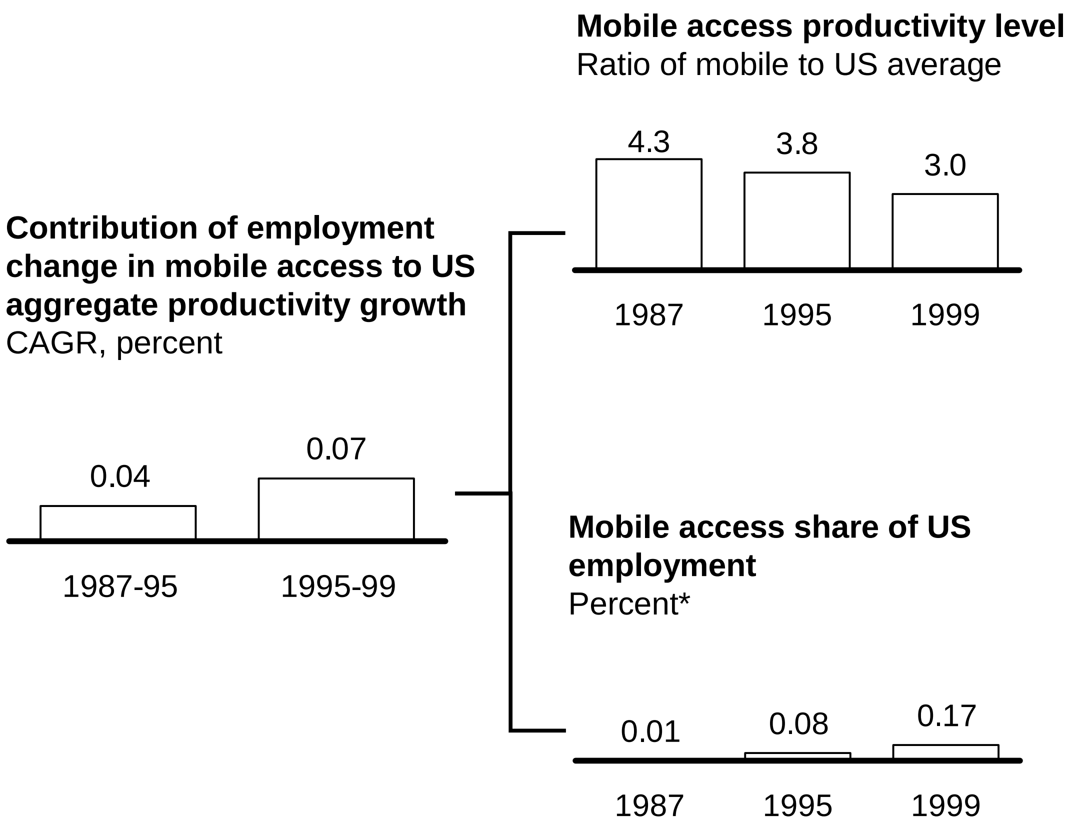
Compound annual growth rates



Source: BEA, MGI analysis

Exhibit 16

MOBILE'S SHARE OF THE ECONOMY INCREASED



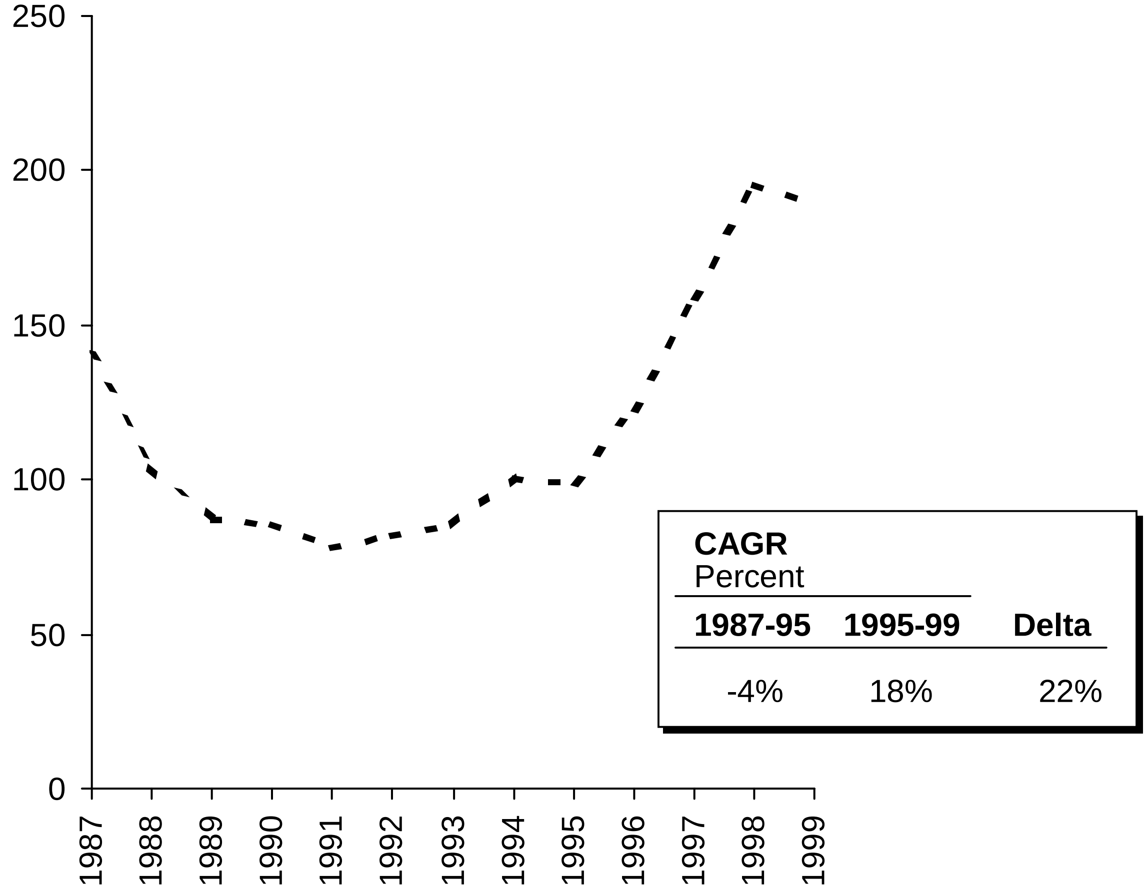
* Share of private-sector employment

Source: BEA, MGI analysis

Exhibit 17

IT INTENSITY GROWTH ACCELERATED DRAMATICALLY

IT capital intensity, thousands of 1996 dollars per employee*



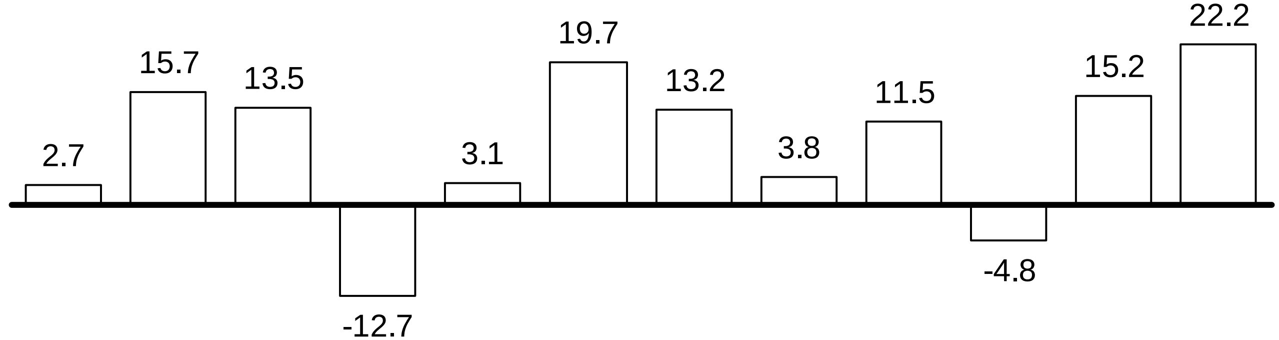
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

Source: BEA, FCC, CTIA, Hoovers, Compustat, MGI analysis

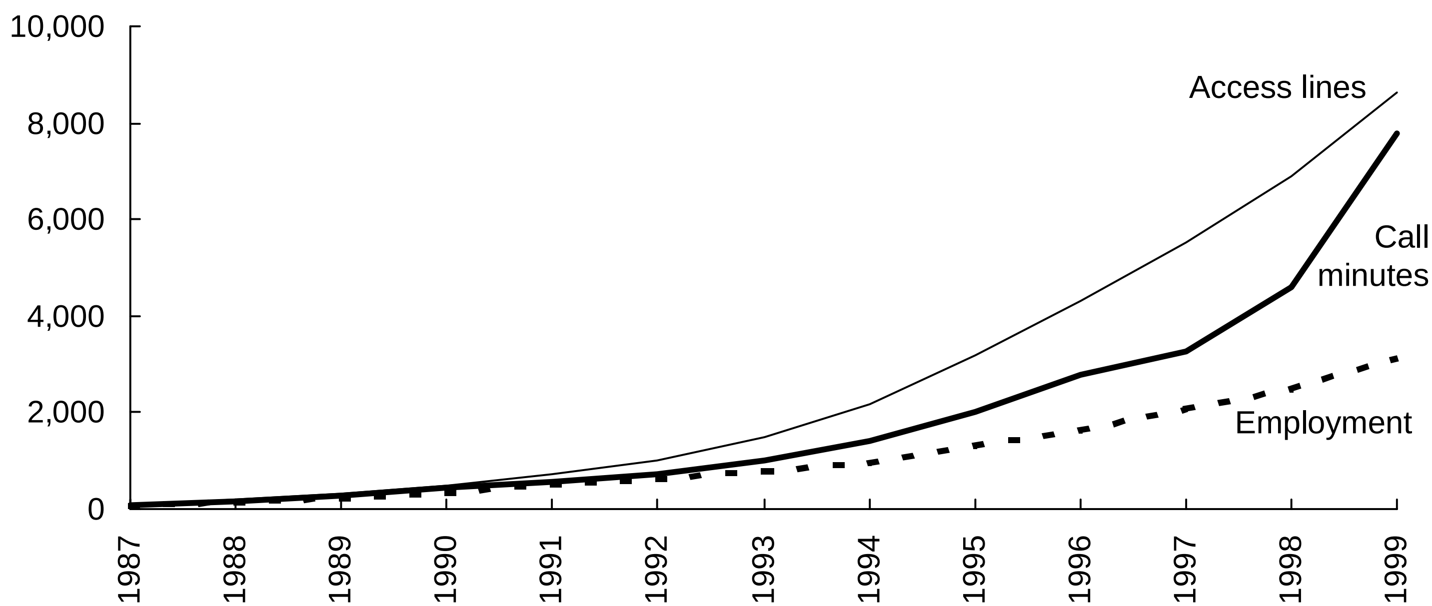
Exhibit 18

PRODUCTIVITY IN MOBILE WAS DRIVEN BY RAPID INCREASES IN OUTPUT

Mobile service annual productivity growth
Percent



Mobile service output and input measures
Indexed, 1987 = 100



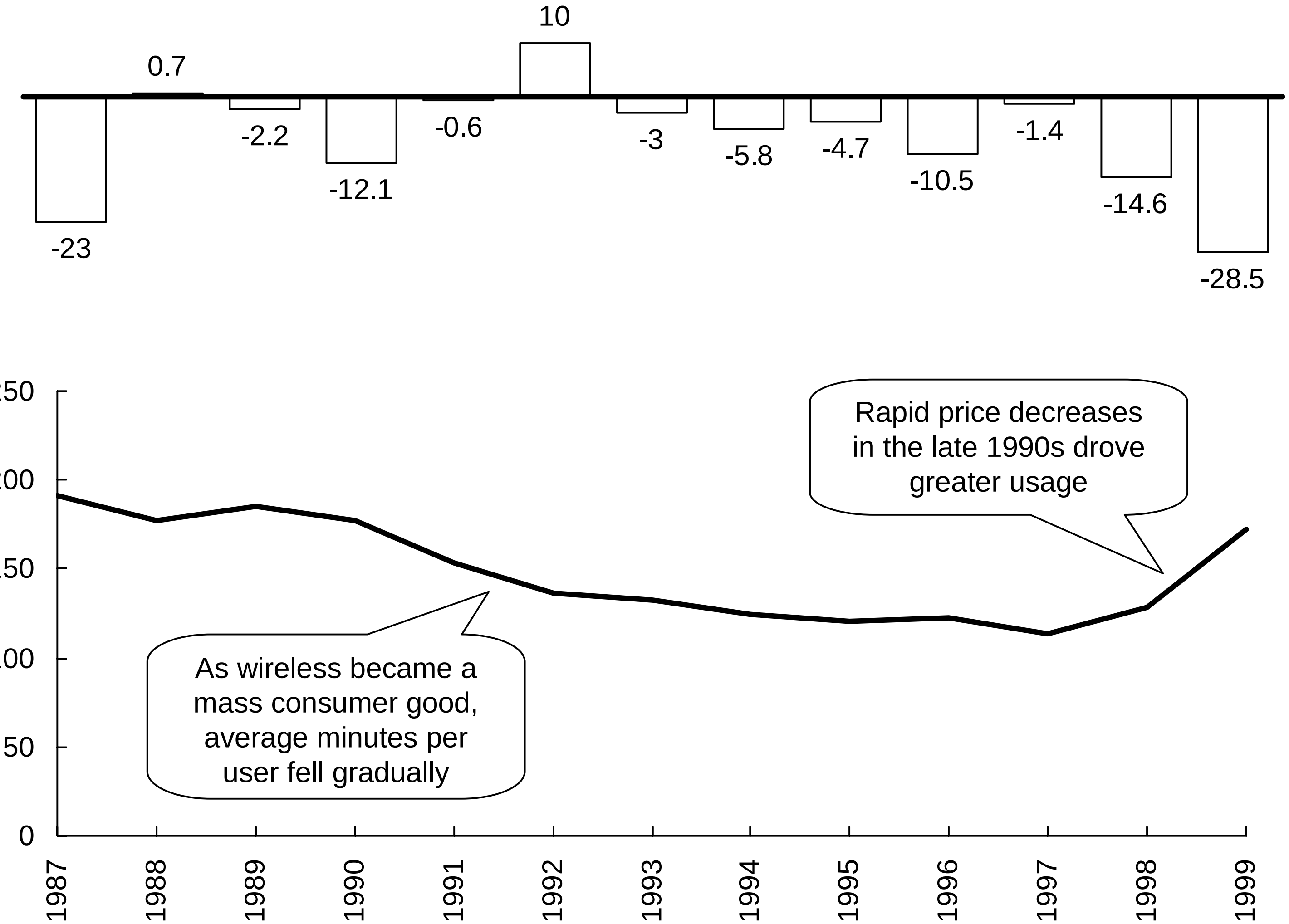
Source: FCC, MGI analysis

Exhibit 19

LOWER PRICES FOR MOBILE CALLS ENCOURAGED USAGE

Mobile phone pricing
Change in total revenue per minute*, percent

Mobile phone usage
Minutes per subscriber per month



* Simple division of total industry revenues by total call minutes

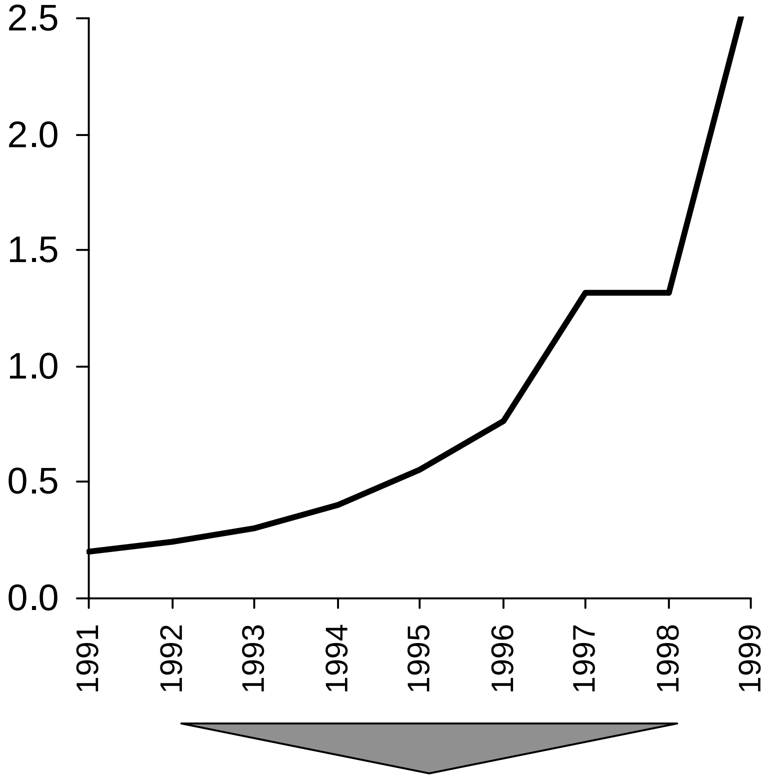
Source: CTIA, MGI analysis

Exhibit 20

MOBILE CAPACITY INCREASED DRAMATICALLY IN THE LATE 1990s

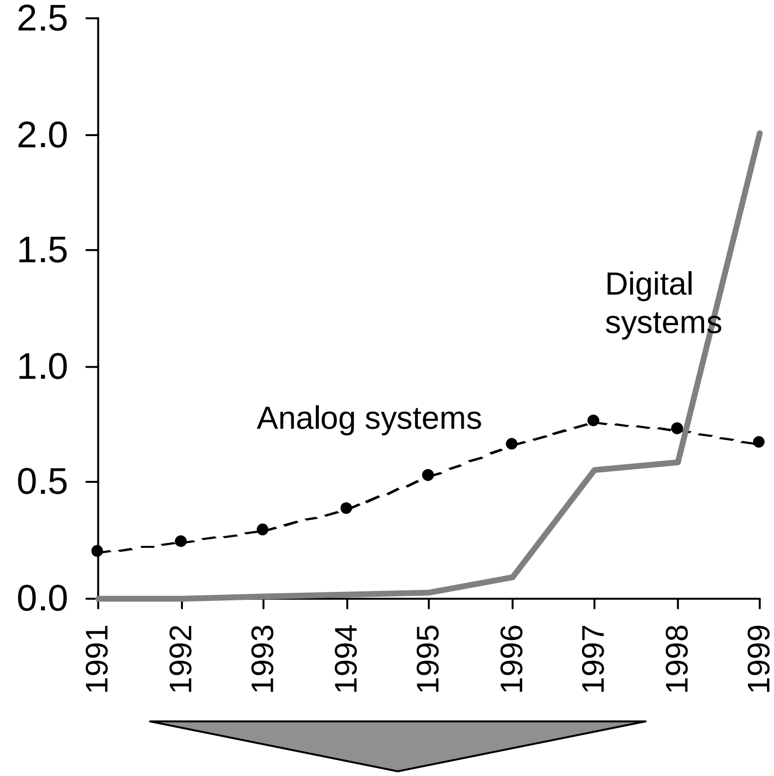
Millions of simultaneous calls (channels)

Call capacity installed



Surge in capacity made rapid increases in usage possible

Type of capacity installed



Capacity increase was driven by installation of equipment based on new digital standards

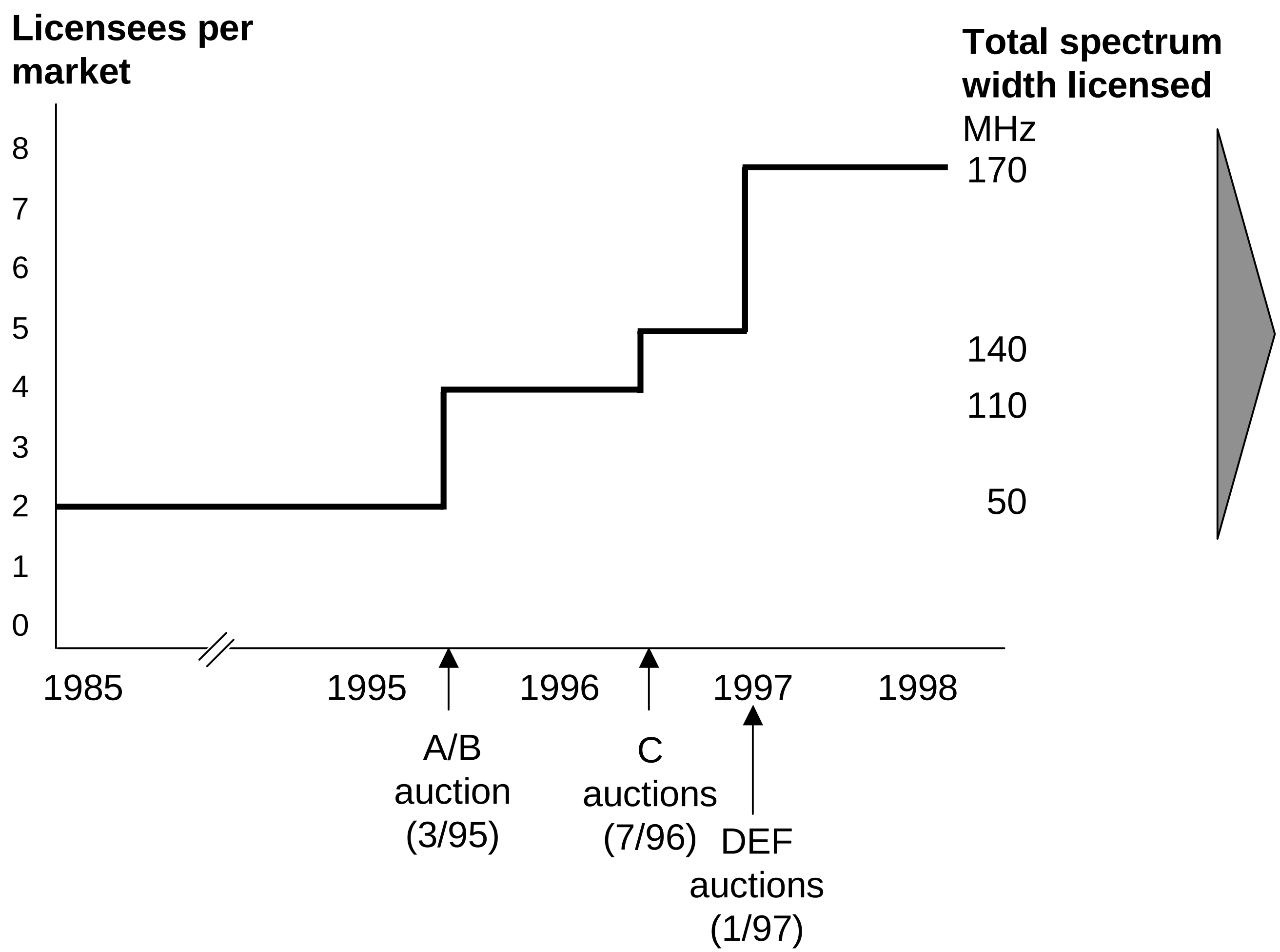
Note: Capacity utilization as measured by MGI - total call minutes divided by theoretical call minutes possible (channels x 60 minutes/hour x 24 hours/day x 365 days/year) - stayed in a fairly narrow band around 10% during this time period. (This does not correspond to typical industry measures of capacity utilization, which are based on usage measured at peak periods.)

Source: CTIA, MGI analysis

Exhibit 21

INCREASED CAPACITY CREATED BY GOVERNMENT AUCTIONS OF ADDITIONAL (PCS) SPECTRUM

Number of mobile services competitors per market in U.S., 1985-98



- Tripling of licensed spectrum from 1995-97
- Overall shift was from 2 to 4-5 competitors per market
  – A and B blocks created new PCS competitors
  – Nextel entered in the early 90s with SMR service (entirely different band)
- Remaining blocks not utilized for cellular
  – C block tied up in litigation
  – D, E, F blocks too small for viable cellular service

Source: NWRA, FCC, MGI analysis

Exhibit 22

CHANGES IN TECHNOLOGY AND REGULATION WERE RESPONSIBLE FOR HIGHER MOBILE PRODUCTIVITY

● Important (>50% of acceleration)

◐ Somewhat important (10-50% of acceleration)

○ Not important (<10% of acceleration)

External factors	• Demand factors (macro-economic/financial markets)	○	
	• Technology/innovation	●	• Digital cellular standards, other innovations • Spectrum auctions 1995-97
	• Product market regulation	●	
	• Up-/downstream industries	○	
	• Measurement issues	○	
Industry dynamics	• Competitive intensity	●	• Move from 2 to 5 competitors in most markets • Lower capital cost per channel with digital
	• Prices/demand effects*	●	
Firm-level factors	• Output mix	○	
	• Capital/technology/ capacity	●	• Huge increase in capacity (while maintaining utilization)
	• Intermediate inputs/ technology	○	
	• Labor skills	○	
	• Labor economies of scale	●	• Large increase in minutes per subscriber, while labor driven primarily by number of subscribers
	• Organization/process design	○	

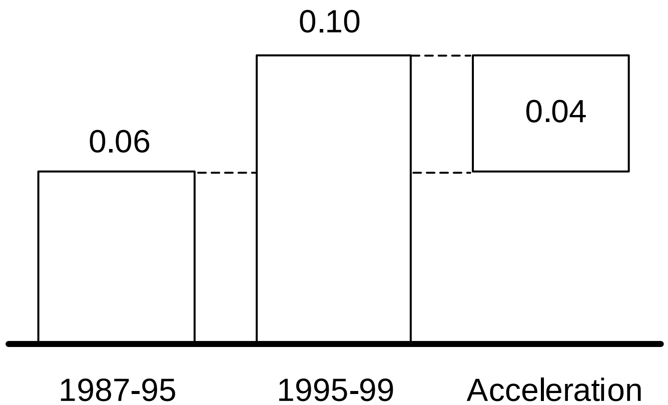
* Lower prices were enabled by digital equipment's better price/performance ratio, as well as the increase in competitive intensity

Source: Interviews, MGI analysis

Exhibit 23

LONG DISTANCE CONTRIBUTED TO THE OVERALL US PRODUCTIVITY GROWTH JUMP

Contribution to aggregate productivity growth
CAGR, MGI analysis



- The long distance segment contributed about 0.04% to the aggregate U.S. productivity growth jump of 1.33%*
- This contribution would rank long distance 10th amongst the BEA's industry sectors, if it were treated as a separate industry**

* Note that the long distance contribution is based on MGI analysis (which yields a total telecom sector contribution of 0.11% to the US acceleration) while the aggregate productivity growth jump is measured with BEA data (which yield a total telecom contribution of 0.07%)

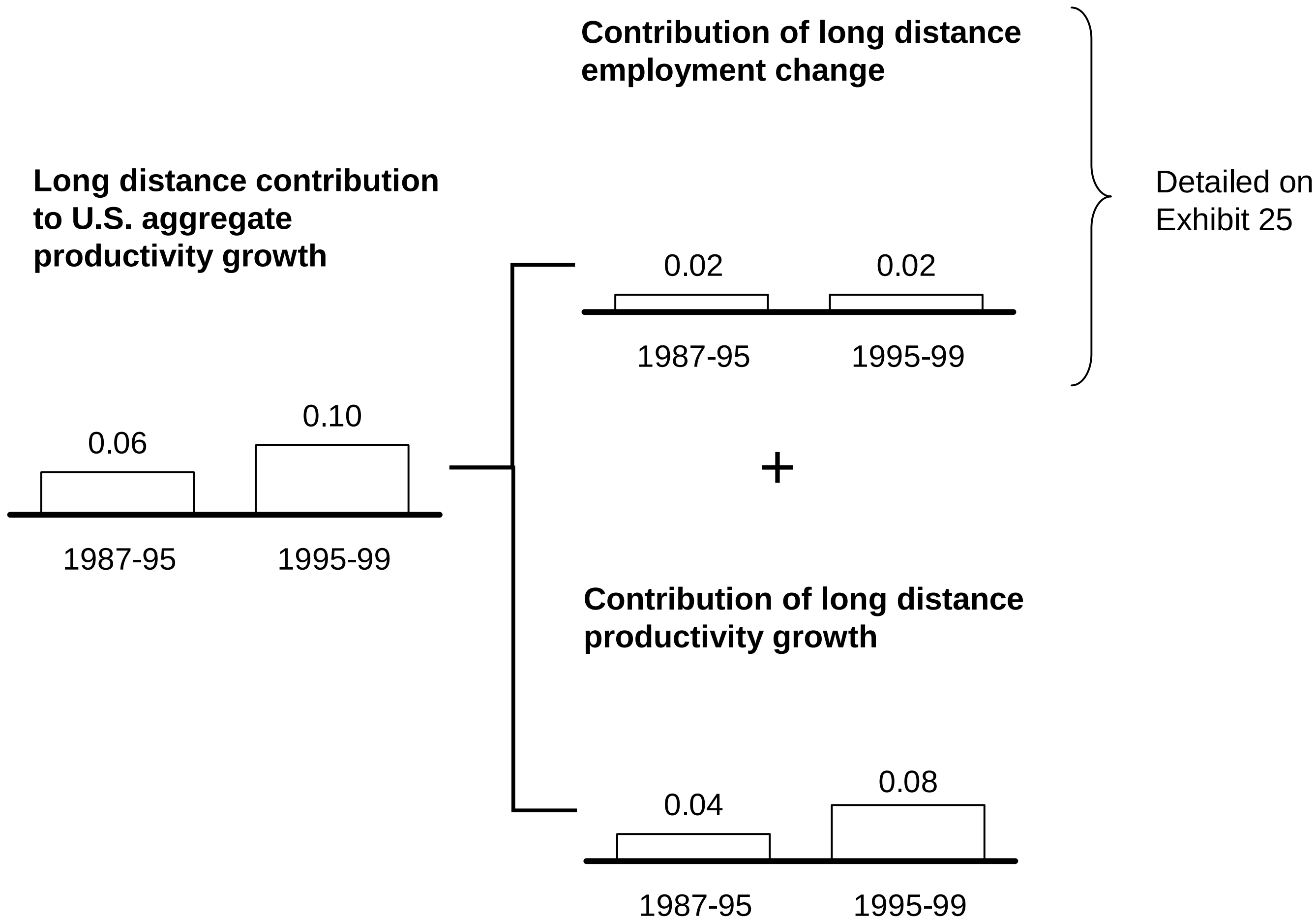
** After the other five MGI "jumping sectors", plus mobile communications, farms, health services, and real estate. This ranking does not include the contribution of the "holdings and investment offices" sector because that sector's high contribution is due to statistical irregularities.

Source: BEA, MGI analysis

Exhibit 24

LONG DISTANCE CONTRIBUTED TO THE US PRODUCTIVITY JUMP BECAUSE ITS OWN PRODUCTIVITY GROWTH ACCELERATED

Compound annual growth rates

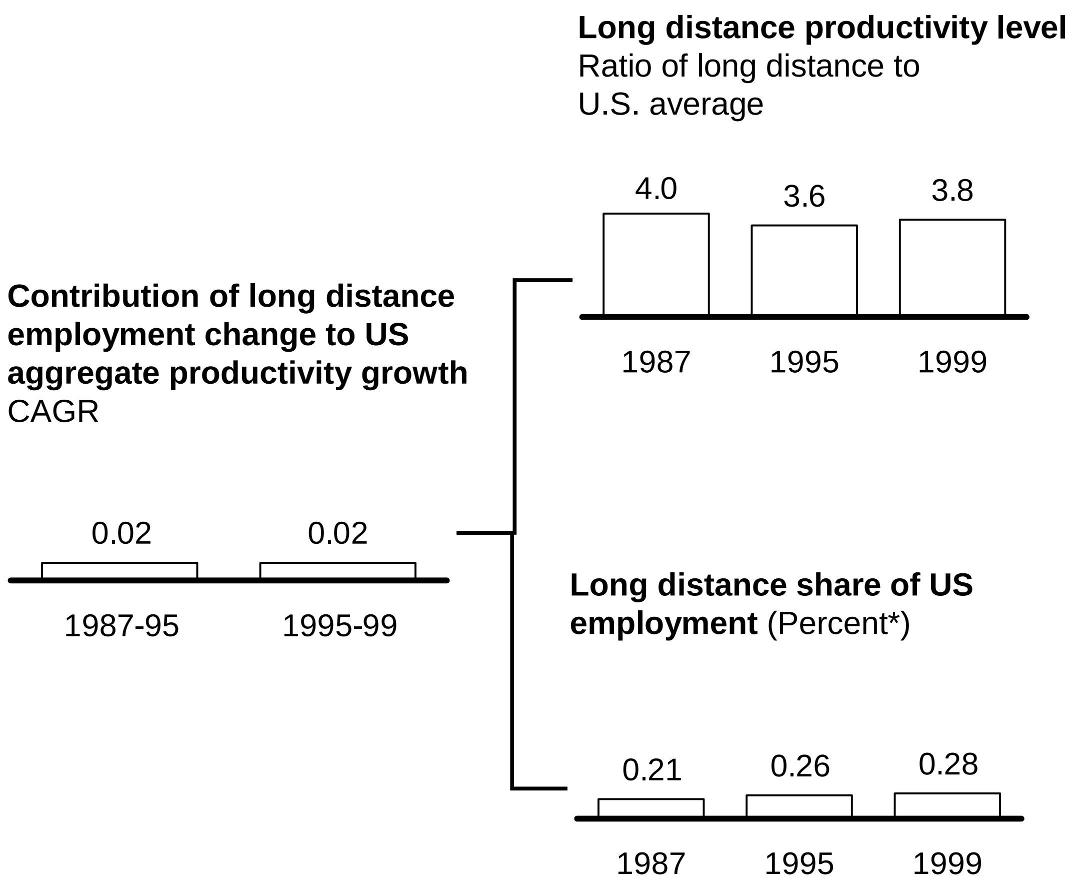


* Share of private sector employment

Source: BEA, MGI analysis

Exhibit 25

CHANGES IN LONG-DISTANCE EMPLOYMENT HAD LITTLE EFFECT ON AGGREGATE PRODUCTIVITY



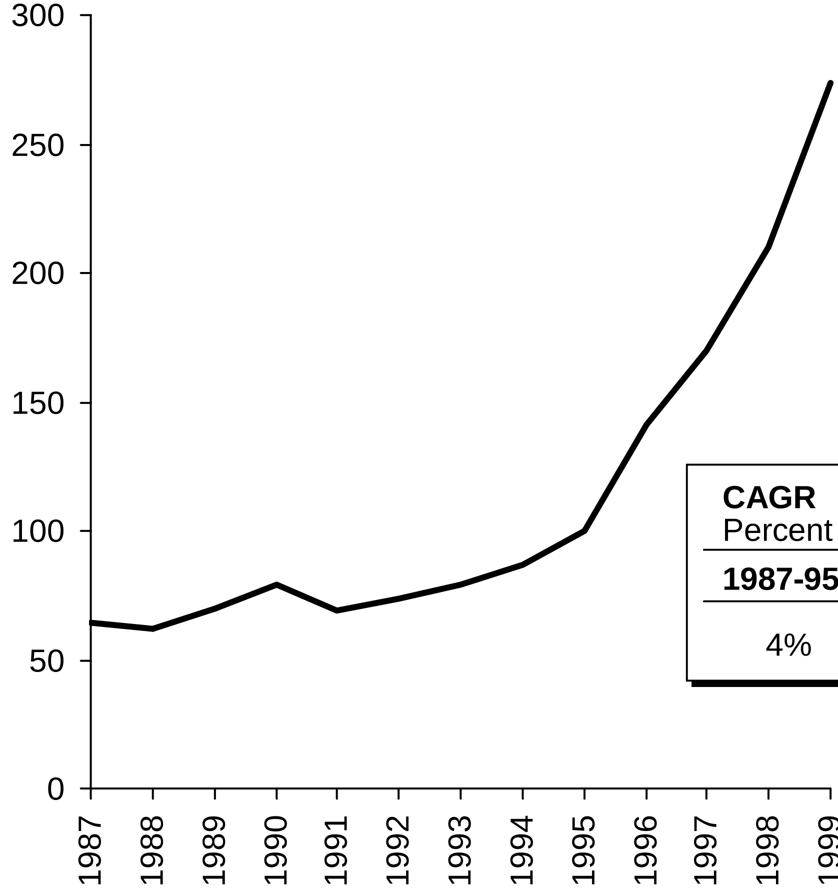
* Share of private sector employment

Source: BEA, MGI analysis

Exhibit 26

IT INTENSITY ACCELERATED DRAMATICALLY

IT capital intensity in long distance, thousands of 1996 dollars per employee*



CAGR
Percent

1987-95	1995-99	Delta
4%	19%	15%

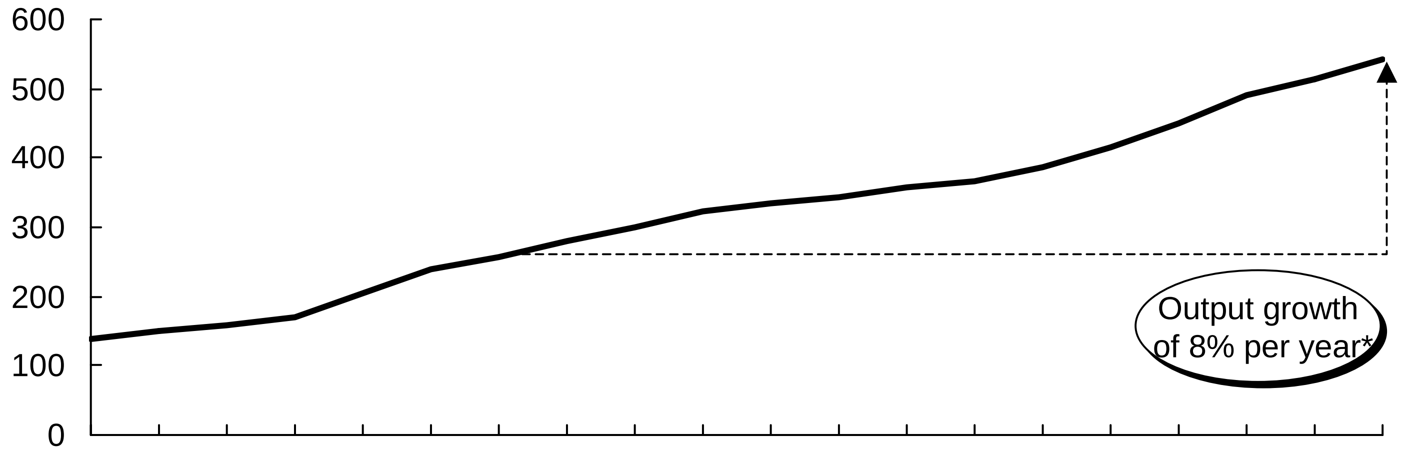
* Communications equipment is included in the MGI definition of IT (and accounts for over 80% of IT investment in the telecommunications sector)

Source: BEA, FCC, Hoovers, Compustat, MGI analysis

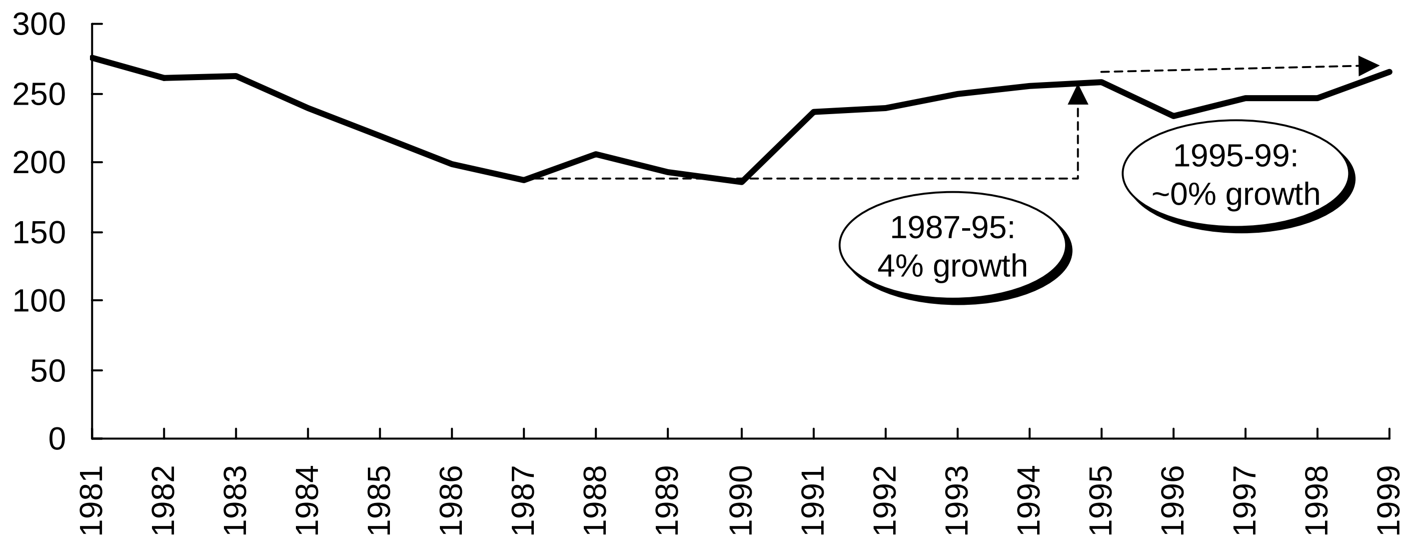
Exhibit 27

A SLOWDOWN IN EMPLOYMENT GROWTH WAS RESPONSIBLE FOR THE 1995-99 PRODUCTIVITY ACCELERATION

Long distance output
Billions of long-distance minutes



Long distance input
Estimated total long-distance voice employees



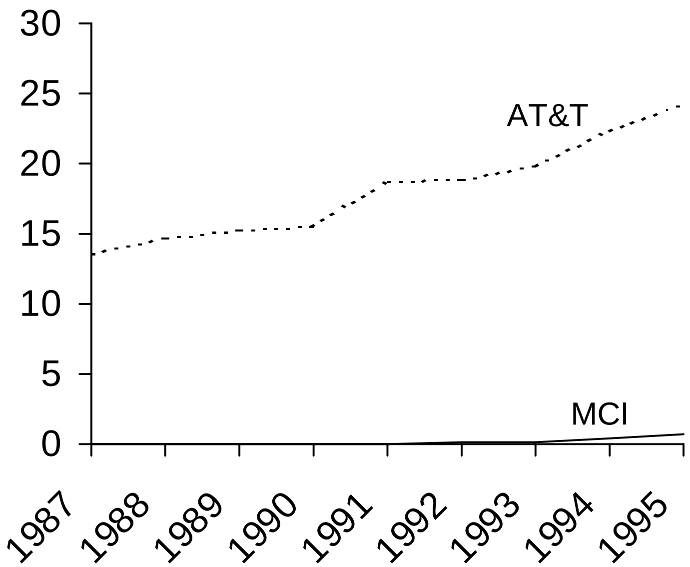
* The actual productivity calculations use a Fisher-weighted index composed of intrastate, interstate, and international minutes

Source: BEA, FCC, Compustat, MGI analysis

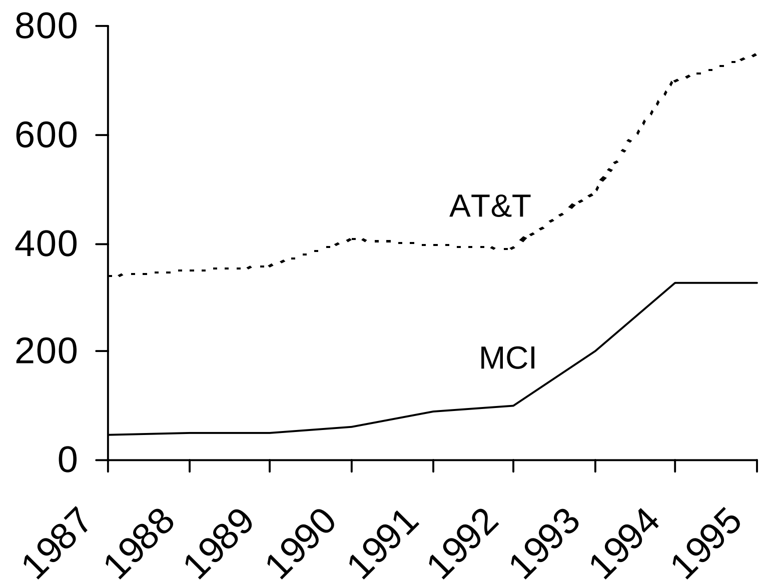
Exhibit 28

SHARE WARS HELPED DRIVE LABOR INCREASES IN THE EARLY 1990s

Selling, general, and administrative expenses
$ Billions



Long-distance advertising expenses
$ millions



"It's marketing – not technology, which is easily replicated – that's making the biggest difference in the telecommunications business these days"

– Timothy Price, EVP/Group President MCI
(as quoted in *Advertising Age*, Nov. 28, 1994)

Source: *Advertising Age*, Compustat

Exhibit 29

THE LEGACY OF REGULATION WAS BEHIND THE EVENTUAL PRODUCTIVITY ACCELERATION IN LONG DISTANCE

● Important (>50% of acceleration)

◐ Somewhat important (10-50% of acceleration)

○ Not important (<10% of acceleration)

External factors

- Demand factors (macro-economic/financial markets) ○
- Technology/innovation ○
- Product market regulation ●
- Up-/downstream industries ○
- Measurement issues ○

Longer-term effects from breakup of AT&T

Industry dynamics

- Competitive intensity ●
- Prices/demand effects ○

Competitive intensity stopped decreasing (high in 1984-86, lower through mid-1990s)

Firm-level factors

- Output mix ○
- Capital/technology/ capacity ○
- Intermediate inputs/ technology ○
- Labor skills ○
- Labor economies of scale ○
- Organization/process design ●

Marketing efforts and call plan proliferation slowed*

Note

- Data networks grew rapidly during this period, but still represented a small portion of total revenue in 1999
- An analysis of long distance productivity for the data segment only (based on limited data and estimates) suggests high, but not accelerating, productivity
- Key factors (see following pages)
  – External innovation in technology
  – Increase in competitive intensity as multiple providers built new networks
  – Very high capital deepening

* Some of the observed employment increase in long distance during this period came from the buildup of operations and marketing organizations for data services

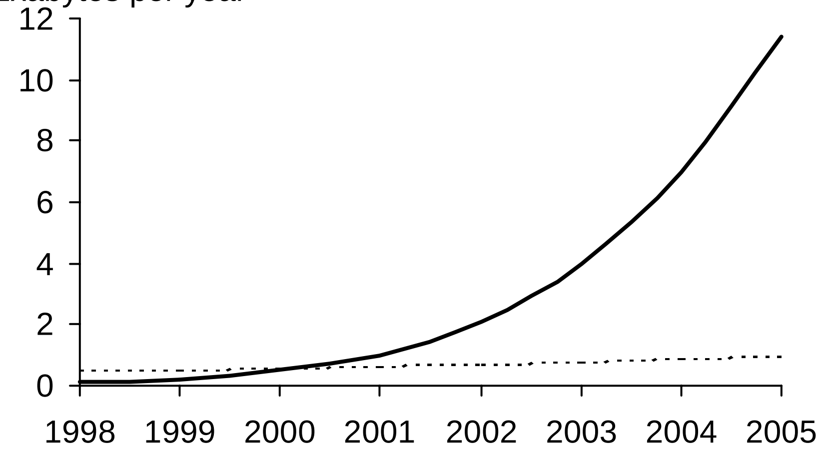
Source: Interviews, MGI analysis

Exhibit 30

TWO FORCES ENCOURAGED NEW ENTRY IN LONG-DISTANCE DATA

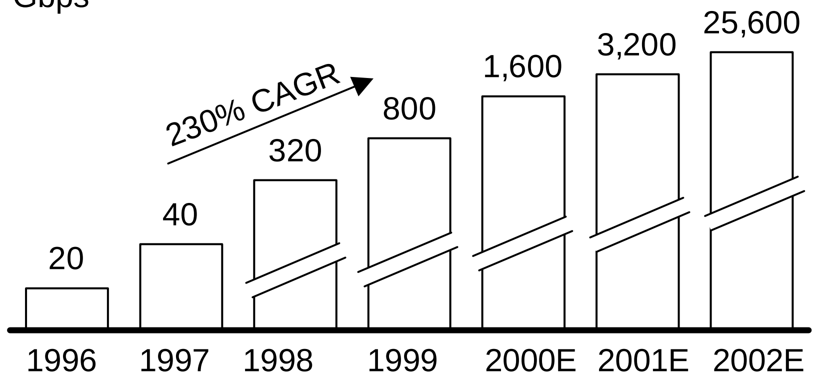
Projected surge in demand

Projected US backbone traffic
Exabytes per year*



Technological discontinuity

Potential capacity of one fiber optic strand
Gbps



- Dense wave division multiplexing
- More rapid date rate per wavelength

- Multiple new entrants building nationwide backbone networks**
  - Frontier/Global Crossing
  - Qwest
  - Level(3)
  - Digital Teleport
  - IXC/Broadwing
  - Touch America
  - Genuity
  - Enron
- Many other players building regional/metro fiber networks

* One exabyte = 2^{60} bytes

** Easy availability of capital enabled the rapid buildout of multiple networks

Source: AT&T Labs, KMI, McKinsey/JP Morgan "IP" and "Backbone" reports

Exhibit 31

SEVERAL FACTORS CONTRIBUTED TO OVERINVESTMENT IN LONG HAUL NETWORKS

● Important (>50% of investment)
◑ Somewhat important (10-50% of investment)
○ Not important (<10% of investment)

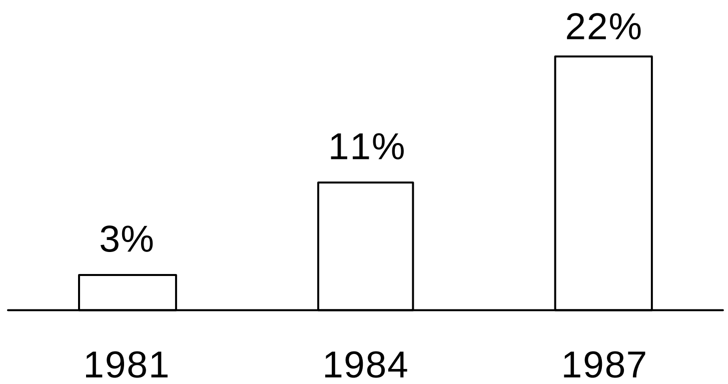
			Explanation
External factors	• Demand factors (macro-economic/financial markets)	◑	• Significant fraction of excess investment attributable to easy capital markets (many new networks funded by late 1990s IPOs)
	• Technology/innovation	●	• Rapid innovation in optics spurred big fixed investments
	• Product market regulation	◑	• Telecom Act of 1996 was expected to increase competition in local market
	• Y2K	○	
	• Unmeasured consumer benefits	○	
Industry dynamics	• Low competitive intensity	○ *	• Many competitive providers of broadband services struggling or bankrupt
	• Lower than expected demand	◑	• Projections for penetration of consumer broadband not met
Firm-level factors	• Unmeasured services to consumers	○	
	• Y2K compliance	○	
	• Investment that may yield future benefits	●	• Disappointing returns to date, but may yield future benefits as data demand expected to grow rapidly
	• Excessive/unnecessary investment	●	• Cheap capital, combined with availability of dramatically better technology, prompted investment that was excessive and too early

* Long distance industry highly competitive, but lower competitive intensity among local loop providers limited penetration of DSL/broadband

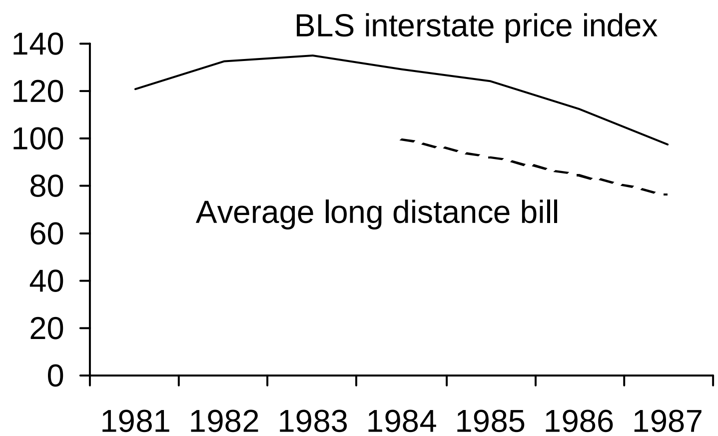
Exhibit 32

INCREASED COMPETITION LED TO A SURGE IN USAGE

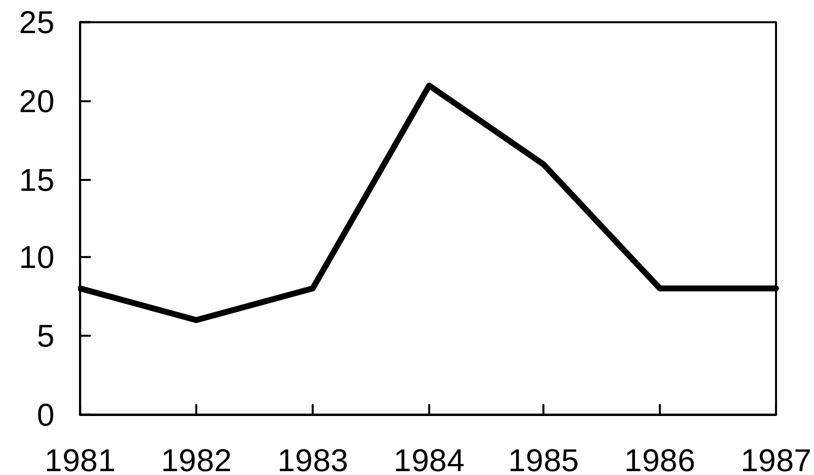
Attacker share of long distance revenue*
Percent



Price per minute of domestic long distance**
Index



Growth in long-distance usage
Annual growth in minutes of usage (percent)



Market stimulated by

- Aggressive marketing of new competitors
- Increased variety of calling plans, options
- Lower prices

* Includes Sprint, Worldcom (incl. the former MCI), and others

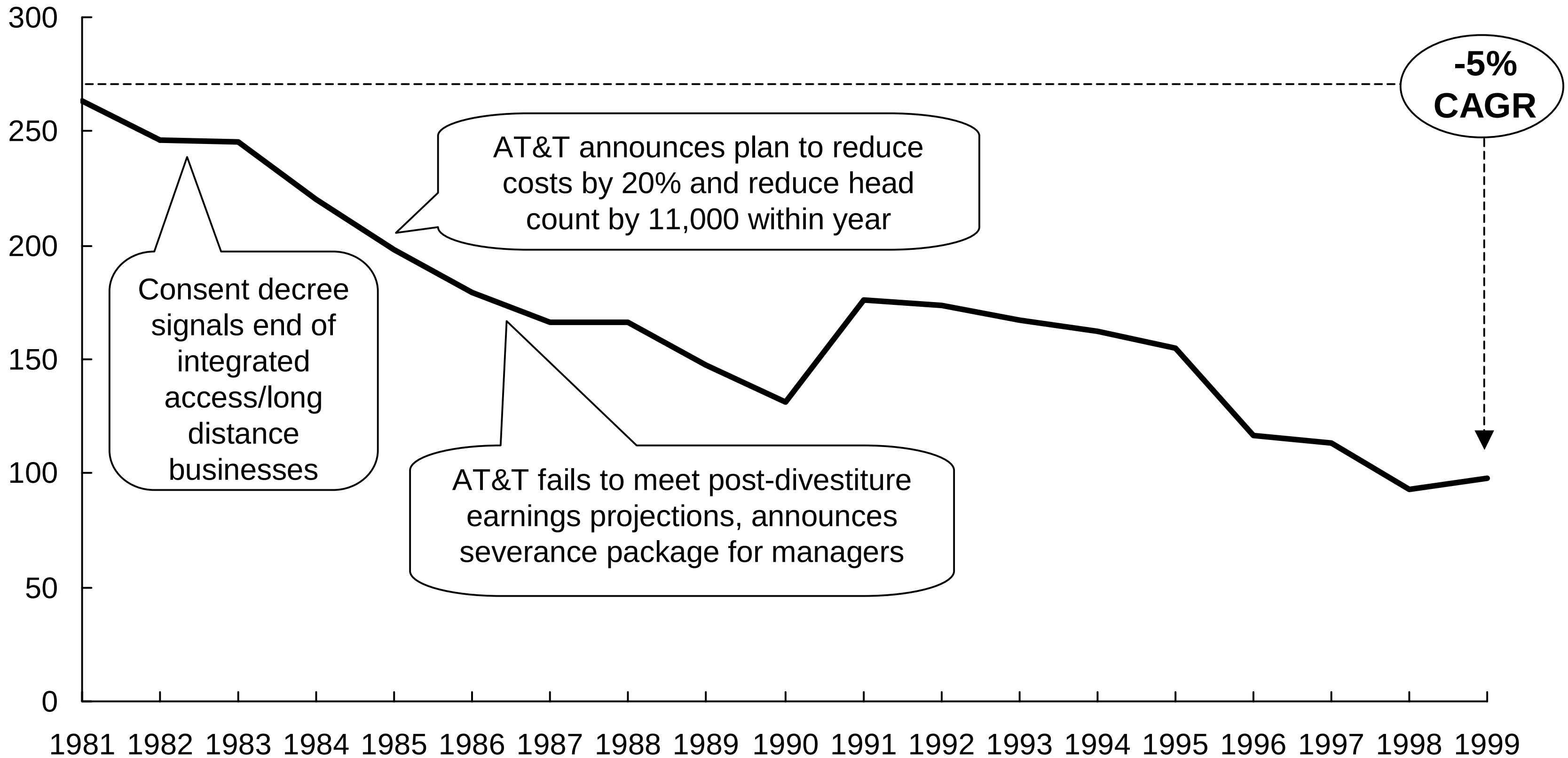
** Measures of average prices understate the drop in the best price available (since not every consumer switched to a lower-cost provider)

Source: FCC, MGI analysis

Exhibit 33

NEW COMPETITION AND THE BREAKUP ENCOURAGED AT&T TO BECOME LEANER

Estimated employees in AT&T long distance operations*, 1981-1999 (thousands)



* These figures are an outside-in estimate based on Compustat data for AT&T employment, less estimated employment for Lucent (1981-96), AT&T Wireless, and TCI (1999)

Source: FCC, Compustat, article search, MGI analysis

Exhibit A1

HOW MGI DEFINES OUTPUT

MGI output measure

Industry segments	Specific output measures	BEA	BLS	MGI
Local service	Access lines	✓	✓	✓
	Minutes of use			✓
	Call services*			
	Data access lines	✓	✓	✓
Mobile access	Subscribers	✓	✓	✓
	Wireless minutes	✓		✓
Long distance transport	Intrastate minutes	✓	✓	✓
	Interstate minutes	✓	✓	✓
	International minutes	✓	✓	✓
	Delivered bandwidth			✓

* Call services refers to features such as call waiting, caller ID, and other operator or software-enabled services. Due to a lack of reliable time-series data, these were not included in the MGI output measure

Source: BEA, BLS, interviews

Securities and commodity brokers, dealers, exchanges, and services

SUMMARY

The securities sector accounted for nearly one-fifth of the total US private sector, nonfarm labor productivity growth jump from 1995 to 1999, making it the third largest contributor of any sector in the economy. The sector's labor productivity growth rate accelerated more than 7 percentage points between the two periods (1987-95 and 1995-99).

The sector's strong productivity performance was due to the combination of buoyant financial markets, exploitation of IT (information technology), and procompetition regulations.

¶ The extraordinary performance of the stock market between 1995 and 1999 contributed to productivity growth by triggering heightened equity-trading activities in the late '90s, and inflating both the value of portfolio assets under management and the transaction volumes of investment banking services.

¶ An information intensive industry, the securities sector has been an aggressive adopter of information technology to automate trading processes. IT has been substituted for labor to create enormous trading capacity over the last 20 years. On-line trading, the latest example of automation, contributed significantly to the productivity growth acceleration.

¶ The SEC's 1997 Order Handling and 16th Rules promoted competition among market makers and lowered price floors, which resulted in lower equity trading costs, and contributed to more trading volume by active traders.

While the sector as a whole experienced an impressive productivity jump, its two major subsectors had very different labor productivity profiles. The Securities Broker and Dealer subsector, which includes securities sales and trading and investment banking services, enjoyed a large labor productivity growth jump. The Portfolio Management subsector, on the other hand, did not show strong productivity acceleration.

Approximately 60 percent of the sector's contribution to aggregate productivity growth acceleration is likely to be sustainable over the next 5 years. While most of the jump from investment banking, non-equity trading activities (e.g. option trading, distribution of mutual fund shares), and portfolio management disappeared with the bull market, the factors that caused the majority of the equity trading and sector mix-shift contributions (e.g., further automation of trading process, continuing penetration of online trading, declining trading costs and growing employment share) should endure.

Securities and commodity brokers, dealers, exchanges, and services

OVERVIEW OF SECURITIES INDUSTRY

During the last decade the securities sector has seen tremendous change characterized by the combination of new technology adoption, managerial innovations, and pro-competition regulations. To provide a context for our analyses, this chapter offers a brief overview of the industry – a basic profile and the sector's contribution to the overall labor productivity jump.

Industry profile

The securities industry is relatively small compared to the other sectors studied by McKinsey Global Institute. IT capital stock per employee of the sector, however, is far above the national average level.

- ¶ The sector represented approximately 0.6 percent of private sector employment and 1.6 percent of total nominal value added (GDP) in the US economy in 1999. It is one of the smallest sectors studied by MGI (Exhibit 1).

- ¶ The accumulated investment in information technology, however, makes the sector among the more IT-intensive sectors of the economy. The industry's IT capital stock per employee was $9,000 in 1996, more than 50 percent above the national average of about $6,000.

As financial intermediaries, firms in the sector perform two major functions: facilitating financial transactions as brokers, dealers and investment bankers, and managing clients' financial assets as investment advisers.

- ¶ Securities brokers/dealers and investment bankers facilitate financial transactions, such as equity and debt trading, securities underwriting, merger and acquisition advising, and financing. Wholesale brokers, such as Goldman Sachs and Morgan Stanley Dean Witter, focus on serving institutional and wealthy individual investors. Most wholesale brokers also underwrite securities issuances and advise on merger and acquisition deals. Retail brokers, such as Merrill Lynch's retail business and Charles Schwab, provide brokerage services to individual investors.

- ¶ Portfolio management firms, such as Fidelity Investments and Franklin Resources, manage mutual funds, pension funds, and private accounts of wealthy investors. They typically charge a percentage fee of total assets under management for their services.

MGI used a definition of the securities sector similar to that used by the US Bureau of Economic Analysis (BEA). MGI covered most services of securities brokers and dealers and portfolio management subsectors, which, when combined, accounted for more than 95 percent of the sector's revenue and 90 percent of paid employees based on the 1997 Census (Exhibit 2). Other subsectors were ignored because they are too small to have a significant impact on the overall results and data are not available.

Importance of securities sector to the overall question

The securities sector's contribution to the aggregate labor productivity growth jump came from two sources – a within-sector productivity growth jump and a sector mix shift (Exhibit 3).

¶ Most of the sector's contribution, 0.19 percentage points out of 0.25 percentage points, was the result of a significant labor productivity growth jump within the sector (Exhibit 4).

¶ The securities sector also contributed to the economy-wide labor productivity growth acceleration through a sector mix shift effect. The securities sector's productivity level is 2 times higher than the national average. In addition, the industry's share of employment also increased from 0.5 percent in 1995 to 0.6 percent in 1999. In concert, those forces yielded a mix-shift contribution of 0.06 percentage points to the aggregate productivity growth jump (Exhibit 5).

The sector also exhibited a significant jump in IT intensity growth. The industry dramatically shifted the focus of capital investment towards IT investment during 1995-99. The growth rate of real IT capital intensity rose from 4 percent in 1987-95 to 17 percent during 1995-99, while the growth rate of total capital intensity decreased from 8 percent during 1987-95 to 2 percent during 1995-99 (Exhibit 6).

LABOR PRODUCTIVITY PERFORMANCE

Although MGI generally favors a productivity measure based on value added in order to take into account changes in vertical integration or outsourcing, we based our measure of productivity for the securities sector on physical outputs, in order to be able to break down data for microeconomic causality analysis. Differences between our output measure and a value added based measure is explored in appendix. MGI's measure, like BEA's, yielded a significant labor productivity growth jump between 1987-95 and 1995-99.

MGI identified physical output measures, such as the number of trades for equity trading and assets under management for portfolio management, for each of the sector's eight major service lines. Physical output measures were then aggregated using the Fisher formula (appendix). For labor inputs, MGI adopted BEA's number of persons employed in production (PEPs).

This methodology yielded an acceleration in labor productivity growth from 7 percent in 1987-95 to approximately 14 percent in 1995-99 (Exhibit 7).

The productivity growth jump calculated by MGI was similar to that based on BEA's gross output measure. (MGI's measured jump is approximately seven percentage points versus nine percentage points for the BEA (Exhibit 8).) Two factors caused most of this difference
(Exhibit 9):

- ¶ MGI has different output measures for key services lines, such as: The Fisher Index of different trading channels, e.g., wholesale, full-service retail, discount retail and online, versus BEA's single measure for all equity trading channels (see appendix).

- ¶ BEA and MGI also have different coverage of some services lines, such as portfolio management and interest income in the "All other revenues" category of the SEC Focus report[1] (see appendix).

The SIC definition of the sector corresponded to two separate micro-economic markets, securities brokers and dealers (including investment banking), and portfolio management (Exhibit 10). Each has different productivity trends and contributions. We will analyze each one separately (Exhibit 11).

- ¶ Securities brokers and dealers contributed 0.14 percentage points to the aggregate labor productivity growth jump. Productivity growth acceleration within the subsector accounted for most of the contribution (0.1 percentage points out of 0.14 percentage points). A sector mix-shift effect contributed the remaining 0.04 percentage points.

- ¶ Portfolio management contributed 0.03 percentage points to the aggregate labor productivity jump, of which 0.02 percentage points were the result of a sector mix-shift effect. Only 0.01 percentage points resulted from productivity growth acceleration within the subsector.

[1] The Focus Report is the mandatory filing by brokers and dealers to the SEC, which includes detailed income statements and balance sheet information. "All other revenues" is the last revenue item on the Focus Report's income statements.

SECURITIES BROKERS AND DEALERS

The securities brokers and dealers subsector includes firms conducting both equity and fixed income securities brokering and dealing business, as well as investment banking activities. The subsector experienced a significant labor productivity jump between 1995-99. This was the result of the aggressive adoption of IT, a buoyant financial market, and procompetition regulations. As the subsector represents the majority of the activities of the securities sector, we analyzed it as though it were a separate industry. Consequently, the structure of this section also resembles that of a separate case, including an overview, the causality of the labor productivity jump, and the outlook for 2001-05.

Overview of securities brokers and dealers subsector

The securities brokers and dealers subsector represents the majority of employment, as well as revenues, of the securities sector. The subsector experienced an extraordinary labor productivity growth jump during 1995-99. Consequently, it accounted for most of the securities sector's contribution to aggregate labor productivity growth jump.

¶ **Securities brokers and dealers subsector profile.** The security brokers and dealers subsector includes all the brokers and dealers of publicly traded securities, as well as investment banks that are facilitating and financing the issuance of equity and debt securities. The asset management divisions of brokerage firms, however, are included in the portfolio management subsector.

- Securities brokers and dealers and investment bankers facilitate the transactions of equity, fixed income, and derivative securities. In addition, they facilitate the distribution of shares of mutual funds. Finally, they provide investment banking services, i.e., they assist clients raising equity and debt capital from the public markets through underwriting and advise companies on mergers and acquisitions.
- The subsector accounted for 73 percent of 1999 employment in the securities sector. Firms in the subsector have different focuses. Wholesale brokers, such as Goldman Sachs and Morgan Stanley Dean Witter, focus on serving institutional investors and wealthy individuals. Retail brokers, such as Merrill Lynch brokerage, Charles Schwab, and E*TRADE, get most of their trading business from individual investors. Over the last 10 years, many wholesale and retail brokers merged to create firms serving both segments.

¶ **Importance of securities brokers and dealers subsector to overall question.** The sub-sector contributed 0.14 percentage points to the aggregate labor productivity growth jump due to the combination of a significant labor productivity growth increase within the sector and a sector mix shift (Exhibit 12).

- Of the 0.14 percentage point contribution, 0.10 percentage points were the result of within-sector productivity improvement. The remaining 0.04 percentage point contribution resulted from a sector mix shift. The mix shift was caused by the combination of a high productivity level – more than 2 times the national average in 1999, and growing employment share – from 0.42 percent in 1995 to 0.46 percent in 1999 (Exhibit 13).

- Equity trading is the biggest contributor to the within-sector productivity growth jump (approximately 0.06 percentage points of the 0.10 percentage point total). Investment banking services and other trading related services (e.g., margin lending) accounted for the remaining 0.04 percentage points (Exhibit 14).

Labor productivity performance

The labor productivity growth for the subsector increased from 7 percent during 1987-95 to 19 percent during 1995-99, resulting in a jump of 12 percentage points.

- MGI's labor productivity measure for securities brokers and dealers adopted the Fisher Index of physical outputs for all services, such as the number of trades for equity trading and the number of contracts for option trading, as output measure. Labor inputs equaled the total employment of the entire securities sector, less portfolio management employment (appendix).

- The subsector's output growth rate increased 16 percentage points across the two periods while growth in the number of employees only increased by 4 percentage points. These divergent trends yielded a labor productivity growth jump of 12 percentage points within the subsector (Exhibit 15).

Explaining the jump in 1995-1999 labor productivity growth

Although equity trading is the most important business activity of security brokers and dealers, other services such as investment banking and the distribution of mutual fund shares also contributed significantly to the overall productivity jump. As different service lines have different labor productivity performances, as well as different causalities, we divided them into two groups – equity trading and other services. The causalities are explained separately.

¶ **Explaining the contribution of equity trading**. Equity trading accounted for the majority of the subsector's within-sector contribution to the aggregate productivity growth jump. IT-enabled automation, buoyant financial markets, and procompetition regulations from the SEC caused the large equity trading productivity growth jump. Exhibit 16 summarizes the causality analysis, which is explained with more details hereunder.

- **Firm-level ("operational") factors.** Firms have been investing heavily in IT to automate equity trading systems since the 1980s. The impact of the automation can be disaggregated into two aspects: labor economies of scale and labor substitution (Exhibit 17).
  - Labor economies of scale are significant when there is a high percentage of fixed labor. More than 50 percent of labor in equity trading does not vary with trading volume thanks to previously highly automated trading processes (Exhibit 18). To estimate the importance of labor economies of scale to the productivity jump, we applied the same level of fixed labor of 1995 to 1996-99. While output surged, the "free" productivity growth contributed half of equity trading's productivity growth jump (Exhibit 19).
  - The industry has been continuously improving labor productivity by substituting computers for labor starting in the back office operation and expanding to the front office processes.
    - Retail on-line trading has been a significant part of the automation process since 1995. It contributed to the productivity acceleration of equity trading through labor savings. MGI estimated on-line trading contributed 10 percent to the productivity growth jump of equity trading (Exhibit 20).
    - The continuous efforts of the industry also converted manual processes, which rely on variable labor, into automated operations, which rely on less labor. (Exhibit 21).
- **Industry dynamics.** Successful entry of on-line brokers since 1995 intensified the competition among brokers. This, consequently, accelerated the pace of the decline of retail trading costs, and sped up on-line trading penetration.
  - E-attackers, such as E*TRADE and Charles Schwab started offering on-line trading to discount retail investors by using the Internet in 1995. At the peak, there were several hundred brokers offering on-line trading services. The intensive competition

resulted in low trading cost and encouraged the rapid growth of on-line trading volume.

– The low cost and convenience made on-line trading so popular that most full-service investors established additional on-line accounts in early 1999 with online brokers[2]. Under the competitive pressure, industry heavyweights (e.g., Merrill Lynch) finally introduced on-line services with low price packages around 1999 to 2000, which turned on-line trade into the dominant trading channel.

- **External factors.** A buoyant stock market inflated asset prices, and encouraged the exuberance of equity trading activities, which led to an output surge. Moreover, the SEC's procompetition regulatory changes accelerated the decline of equity trading costs, thus contributing to the output surge of equity trading.

  – The bull stock market of the mid-to-late 90s had two effects on the output of equity trading. First, trading volume from individual investors soared in response to attractive stock market returns. Second, the number of trades of institutional investors surged due to the dramatic drop of trading costs as a percentage of the dollar volume.

    . Academic investigations have shown that overconfidence of individual investors generated excessive trading volumes. High stock market returns boosted the self-confidence of individual investors, which led to an "irrational exuberance" with respect to trading activities (Exhibit 22).

    . Higher average stock prices during the 1995-99 bull market mechanically reduced wholesale commission costs as a percentage of dollar volume, as most brokers charge institutional investors on a per share and/or per trade basis. Such lower average trading costs allowed active traders to take advantage of more trading opportunities[3], thereby contributing to the increase in the growth rate of trading volumes. This effect can also be demonstrated in terms of absolute dollar gains and cost per share. Keeping trading cost per share constant, as prices per share increase, potential gain per share increase in absolute

[2] According to a Merrill Lynch survey.

[3] As the volatility of stock returns, source of trading opportunities, is independent of price levels.

terms as the volatility of stock market returns remains the same regardless of share prices. This dynamic was meaningful because trading cost is one of the key factors in the trading models of active traders (e.g., hedge funds, active trading mutual funds and proprietary traders of brokerage firms). (Exhibit 23).

– Two major regulatory changes from the SEC in 1997 facilitated the acceleration in the drop of trading costs for investors. Order handling rules enabled the growth of lower-cost competitors – e.g., Electronic Communication Networks, whose share of trading volume on the NASDAQ grew from almost nothing to 35 percent in 3 years. Meanwhile, the quote tick-size changed from one-eighth to one-sixteenth, reducing market makers' effective spreads (Exhibit 22).

¶ **Explaining the contributions of other service lines.** The remaining 0.08 percentage point contribution consists of investment banking (0.02 percentage points), other trading-related services (0.02 percentage points), and a sector mix-shift effect (0.04 percentage points). The key contributor of each was an output growth jump associated with buoyant financial markets.

- **Firm-level factors.** Increasing labor utilization rates during the 1990s bull market boosted the labor productivity of investment banks, while the labor productivity growth of other trading-related services improved through the same mechanisms that benefited equity trading.

  – **Labor economies of scale and capacity utilization**. The output measures for investment banking are the dollar volume of securities underwriting and M&A deals[4]. Investment bankers experienced rapid labor productivity growth during the mid-to-late 1990s by spending more time on activities that generated revenues and output, i.e., deal execution, and less time on client development, i.e., "pitching." Moreover, a buoyant stock market inflated the value of deals, which mechanically led to a higher leverage of labor and, consequently, higher labor productivity (Exhibit 24).

  – **Capital/technology/capacity**. Equity trading-related services, such as margin lending and the distribution of mutual fund shares,

[4] Dollar volumes are used because the benefits derived by customers from the transactions are proportional to the size of the transactions.

benefited from the automation of equity trading processes because they are executed through most of the same processes as equity trading. The degree of IT-enabled automation of option trading processing has also significantly increased in the latter part of the 1990s, although many processing steps still require manual operations.

- **External factors.** The booming economy resulted in a surge of output generated by these services, which led to the labor productivity growth jump.
  - The booming economy in the late 90s generated a large demand for capital, especially in telecommunication and other IT-related industries. A rapid increase of IPOs and debt issuances created the output jump of underwriting services of investment banks.
  - The stock market's performance also directly increased the value of key outputs, in three ways. First, inflated stock prices resulted in higher M&A and equity underwriting deal values, which led to the higher output of investment banking (Exhibit 25). Second, exuberant retail trading led margin-lending balances to explode. Finally, the bull market also attracted more capital into equity mutual funds. As a result, the growth of total new sales of mutual funds through brokers increased between 1995 and 1999.
  - The importance of demand factors to the productivity acceleration is emphasized by recent output reversals in all key areas (Exhibit 26).

In spite of the sector's automation-related productivity growth, its large output jump still caused the sector's share of employment to increase. Combined with high productivity levels, this employment share gain caused the 0.04 percentage point sector mix-shift contribution.

Outlook of securities brokers and dealers subsector, 2001-2005

To assess the sustainability of the 1995-99 productivity growth, we split this productivity growth into the long-term base case growth and the growth acceleration during the period.

We believe that the labor productivity growth rate during 1987-95 represented the long-term labor productivity growth trend of the industry. Stock market performance and IT-enabled automation explained the base case growth rate during 1987-95.

¶ The productivity growth from automation should be sustainable (see hereunder).

- The stock market performance before 1995 was roughly in line with a long-term trend[5], we expect that the growth rate between 1987 and 1995 is sustainable.

Our focus, therefore, is on the sustainability of the sub-sector's contribution to the aggregate productivity jump in 1995-99. Our analysis shows that half of the subsector's contribution to the aggregate productivity growth jump (i.e., 0.07 percentage points out of 0.14 percentage points) is likely to be sustainable. The remaining 0.07 percentage points were primarily the result of cyclical forces and will not be sustainable.

First, our analyses showed that more than 50 percent of the contribution of equity trading (i.e., 0.04 percentage points out of 0.06 percentage points) is likely to be sustainable (Exhibit 27).

- The current pace of trading process automation will continue for at least the next 3 to 5 years. Significant productivity improvement opportunities remain in the current trading system, such as advancing straight through process (STP)[6], automating cross-border trading, and automating call centers with voice response units (Exhibit 27).

- Technology, competition, and deregulation will continue to reduce equity trading costs, thereby generating growth in equity trading volume. Non-online equity trading volume (i.e., number of trades) continued to grow at 30 percent annually even after the market correction of the NASDAQ in the first quarter of 2000, after adjusting for the impact of the smaller average trade size caused by decimalization. We believe that non-online trading is representative of the long-term growth trend of trading activities in light of the continued decline of trading costs. Reduced stock prices following the market correction, however, will slow the pace of decline of trading costs as a percentage of dollar volume compared to that during 1995- 99 (see above for details). Therefore, we expect the growth rate of equity trading to continue to grow slower at 15 to 20 percent for at least the next 3 to 5 years (Exhibit 28 and 29).

- The exuberance of retail on-line trading around 1999 was the result of a surging bull market, and is not sustainable. Behavioral research has shown that retail investors tend to be overconfident during bull markets and, consequently, they generate excessive trading activities. Large on-line trading volumes receded after the crash of the NASDAQ in early-

[5] The CAGR of the S&P 500 index (not including dividend yield) was 8% between 1987 and 1994.

[6] STP is the integrated, hands-off, end-to-end processing of transactions that begins and ends with the client.

2000. The penetration of retail on-line trading, however, is expected to continue to grow in the medium term given its advantages of low cost and convenience over other trading formats.

Moreover, approximately half of the 0.04 percentage point mix-shift contribution from the securities brokers and dealers subsector should endure. While employment growth in the subsector has begun slowing, we believe that the medium-term employment growth rate will remain robust in light of the strong output growth prospects.

Lastly, the within-sector contribution of investment banking (0.02 percentage points), and most of that of nonequity trading activity (0.02 percentage points), was the result of an output surge caused by cyclical forces. We expect that only 0.01 percentage points, which were primarily the contribution of option trading, will be sustainable.

¶ The output jumps of investment banking, margin lending, and the distribution of mutual fund shares were the result of a business cycle as it worked its way through financial markets. They all showed much slower growth, and even negative growth, after the economic slowdown began.

¶ Option trading is going through an automation process similar to that of equity trading. Therefore, option trading's productivity improvement rate is expected to be sustainable over the next 3 to 5 years.

PORTFOLIO MANAGEMENT

Portfolio management companies provide investment advice to individuals and institutional investors. The subsector has experienced constant high growth in assets under management during the last two decades as more Americans have invested their financial assets into equity and fixed income securities. In contrast to the securities brokers and dealers subsector, the portfolio management subsector did not experience a significant post-1995 labor productivity growth jump. Rather, it contributed to the aggregate productivity jump primarily through a sector-mix shift effect.

Overview

The portfolio management industry managed more than $15 trillion in financial assets as of 1999. It accounted for 0.14 percent of employment in the US, and contributed 0.03 percentage points to the aggregate labor productivity growth jump.

¶ **Sub-sector profile.** Portfolio management companies managed assets worth more than $15 trillion dollars in 1999. There are three segments in the subsector: mutual fund management, high-net-worth (HNW) individual separate accounts, and pension fund management (Exhibit 30).

¶ **Importance of portfolio management subsector to the overall question.** Portfolio management contributed 0.03 percentage points to the aggregate productivity growth jump. The contribution was primarily the result of a sector mix-shift effect.

- Only one-third – 0.01 percentage points out of the total 0.03 percentage point contribution of portfolio management – was due to within-sector productivity growth.
- The majority of the contribution (0.02 percentage points out of 0.03 percentage points) was from a sector mix shift. Portfolio management's productivity level is quite high (2.7 times the national average in 1999). Above-average output growth necessitated increased labor, which increased the sector's share of employment from 0.10 percent to 0.14 percent (Exhibit 31). In concert, these factors generated the mix-shift contribution of the subsector.

Labor productivity performance

MGI's output measure is a Fisher Index of assets under management for pension funds, mutual funds, and HNW accounts. The labor input is the number of employees in investment advice (i.e., employment in SIC 6282) (see appendix). The subsector's labor productivity growth increased only slightly from 5.8

percentage points in 1987-95 to 6.9 percentage points during 1995-99 (Exhibit 32).

Explaining portfolio management's contribution to aggregate labor productivity growth jump

The subsector contributed to the aggregate labor productivity growth jump through both within-sector productivity growth and a sector mix shift effect. Although it has enjoyed healthy productivity growth over time, the portfolio management subsector did not see a significant productivity jump during 1995-99. The small within sector labor productivity jump was almost entirely the result of the extraordinary performance of the stock market in the late 90s. The sector mix shift contribution, however, reflected the long-term trend of Americans' increasing participation in mutual funds and pension funds.

- ¶ The within-sector labor productivity jump was almost entirely due to the output growth jump, which was closely related to stock market performance. The output growth jump was generated by increasing growth in the value of equity funds, which was caused by the stock market's performance rather than new cash inflows. Extending the ending point of the second period to 2000 (after the stock market correction) actually causes labor productivity growth to decelerate by approximately 3 percentage points (Exhibit 33).
- ¶ The sector mix-shift contribution resulted from increased participation in mutual funds and pension funds.
  - Portfolio management's productivity growth rate has been higher than the national average productivity growth rate (4 to 5 percent versus 2 to 3 percent) for more than a decade, as output growth has outpaced the growth of employment. Consequently, the productivity level of the subsector has increased from 1.8 times the national average in 1987 to 2.7 times in 1999.
  - Most of the employment in portfolio management is related to the number of accounts. Despite a small portion of fixed labor, a steady, high growth rate in the number of accounts led to an employment growth rate that was above the national average, which mechanically increased the portfolio management sector's share of employment (Exhibit 34).

Outlook of portfolio management, 2001-2005

The sector mix shift contribution of the subsector is expected to endure as increased investment into mutual funds and pension funds continues, requiring an employment growth rate similar to that of the past 5 years. The within-sector labor productivity jump, however, disappeared after the stock market correction of the NASDAQ in early 2000. Although the jump is not sustainable, we expect the long-term base growth rate should continue as a result of the long-term trends toward mutual fund and pension fund investment (Exhibit 35).

¶ The 0.02 percentage point sector mix-shift contribution is likely to be sustainable. Even as financial markets retreated in 2000, portfolio management employment continued to grow at 6 percent in 2000, as reported by the Bureau of Labor Statistics (BLS). The long-term forces that contributed to demand for portfolio management services, and hence employment in, portfolio management are expected to continue over the next 5 years.

- Baby boomers are reaching the age of their highest earning and investing capacity, which should generate continued demand for the investment vehicles of the portfolio management subsector. The US population between the ages of 45 to 64 is projected by the Census to continue growing at 3.2 percent annually until 2005, as it did from 1995-99. (Exhibit 36).

- Mutual funds (both equity and money market) have steadily increased their share of US household financial assets over the past decades (Exhibit 37). This process is likely to continue. Money market mutual funds offer superior returns (compared with bank savings accounts and CDs) to small investors. Even during market downturns, when equity investing retreats, money market funds should still gain share. The long-term expansion of equity investing should also increase the share of equity mutual funds of household financial assets.

¶ The within-sector contribution (0.01 percentage points), however, is unlikely to be sustainable. The clearest evidence for this is that productivity growth within the subsector would have decreased by 4 percentage points if MGI had conducted its analysis from 1995 to 2000, rather than 1995 to 1999. Assuming the within-sector contribution is sustainable would imply a belief that the financial markets' performance in the next 5 years will approach that of 1995-99 – clearly a hazardous assertion.

APPENDIX

Details on productivity measurement methodology

¶ **Output measures.** MGI identified physical output measures for the sector's eight major service lines and then constructed a price-weighted Fisher Index of them (Exhibit A1).

- MGI measured the number of equity trades on the NASDAQ, NYSE, AMEX, and regional exchanges as output for equity trading. To reflect the service (i.e., investment advice) level variations across trading formats, MGI built a Fisher Index of wholesale trades, full-service retail trades, discount non-online trades, and on-line trades, using trading costs as weights.
- As a check, MGI also calculated the Fisher Index of equity trading dollar volumes deflated by GDP deflator, which yielded similar results to a trade-based measure. This result assured us that our measure was not distorted by any bias in the number of trades associated with order bundling and splitting (Exhibit A2).
- For portfolio management, MGI measured total assets under management by pension funds, mutual funds, and HNW accounts, adjusted by the GDP deflator to eliminate the impact of inflation. To accommodate the different service levels of the three service lines, MGI used the fee levels as weights to calculate the Fisher Index as the final output for portfolio management.
- We used dollar values of deals as output measures for underwriting and M&A. Average lending balances, total new sales of mutual funds, and total dollar trading volume of fixed income securities were used as physical outputs for margin lending, mutual fund distribution, and debt trading respectively. We believe that dollar volume is the appropriate measure for these services because customers deprive their benefits proportionally to the value of the transactions. To eliminate the impact of inflation, the GDP deflator adjusted dollar values.

¶ **Price of physical outputs**. To construct a Fisher Index of the sector, MGI calculated prices of different services by dividing nominal revenues by quantity of their respective physical outputs.

- MGI's revenue data for the services of securities brokers and dealers and investment banking were based on SEC Focus reports with major adjustments to equity trading and margin lending.

   - MGI estimated the spread gain of equity trading market makers (on the NASDAQ) and the specialists (on the NYSE) on the basis of average quoted spreads and their associated trading volumes. The purpose of the adjustments was to eliminate dealers' capital gains from proprietary trading, which is not trading cost to the public. In addition, commissions paid to other brokers were excluded to avoid double counting.

   - MGI calculated net interest income for margin lending by subtracting T-bill rate-based interest expenses from margin lending interest incomes in the Focus report.

- We estimated revenue weights for portfolio management by applying average fee levels for pension funds, mutual funds, and HNW accounts to their respective average value of assets under management.

¶ **Labor measure**. MGI adopted BEA's PEP as labor inputs for our productivity analysis (Exhibit A3).

- Labor inputs for portfolio management were based on full-time employee (FTE) data for the investment advice sector (SIC 6282) supplied by the US Bureau of Labor Statistics. We then adjusted these figures to a PEP basis by applying the percentage of FTE/PEP for the entire securities sector.

- Labor inputs for the securities brokers and dealers subsector was calculated by subtracting portfolio management PEP from total securities sector PEP.

Reconciliation with results based on BEA data

¶ Differences exist between MGI's labor productivity measure and that derived from BEA data:

- BEA value-added data (the same data that BEA uses to construct overall GDP for the US economy) indicate that labor productivity grew 5.6 percent annually from 1987 to 1995 and then jumped to 20.6 percent from 1995 to 1999. The sector's contribution to the aggregate productivity jump is 0.25 percentage points out of the 1.33 percentage point total.

- MGI's approach, described above, yielded labor productivity CAGR of 7.3 percent from 1987 to 1995 and 14.5 percent from 1995 to 1999, and a contribution to the aggregate productivity growth jump of 0.17 percentage points out of 1.33 percentage points, once converted to a value-added measure.

¶ MGI's labor productivity measure differs from that calculated using BEA data for three reasons:

- First, MGI used different output measures for major service lines.
  - The difference of portfolio management output measures has the largest impact. MGI measured the output of portfolio management by constructing a Fisher Index of assets under management of mutual funds, pension funds, and high-net-worth accounts. BEA did not have an independent measure for portfolio management, which is covered implicitly by extrapolation. BEA's gross output measure is based on the SEC's Focus report, which covers only the securities brokers and dealers and investment-banking subsector. To capture the outputs of services not covered by the Focus report, BEA extrapolated adjusted Focus report data according to the census results of benchmark years, i.e., 1987 and 1992. Moreover, BEA adopted implied price deflator of securities commissions as price index for mutual funds rather than the index of management fee levels used by MGI.
  - For equity trading, MGI constructed a Fisher Index for trading volumes of different channels, i.e., wholesale trading, full-service retail trading, discount trading, and on-line trading, to account for the different service levels. BEA used single-trade volume data for all channels.
  - For distribution of mutual fund shares and other revenues, BEA takes SEC Focus report revenue data deflated by price index for other securities services as output measure. MGI takes into consideration the price changes of these services by constructing physical measure for each service line.
- Second, there are differences in scope between MGI and BEA's gross output measures (Exhibit A4 and A5).
  - BEA includes the "All other revenue" category of the SEC Focus report in its gross output measure. MGI excluded this category because most of the revenue is gross interest income from financing activities and should be canceled by corresponding interest expenses.
  - MGI included margin lending in its output measure while BEA does not.
  - MGI also excluded outputs of some minor service lines, such as exchanges and researches that are not wrapped into trading.

- Finally, the MGI output index measures gross output while the result from BEA data is using value added. The industry has a high percentage of fixed-intermediate inputs, which are defined as inputs that do not vary with gross output. As gross output grows, value-added output is likely to grow faster than gross output, which leads to higher growth acceleration of labor productivity under value-added based productivity measures (Exhibit A6 and A7).

CONFIDENTIAL

Productivity in the Securities Sector

MGI/HIGH-TECH PRACTICE NEW ECONOMY STUDY

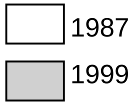
Final report exhibits

October 2001

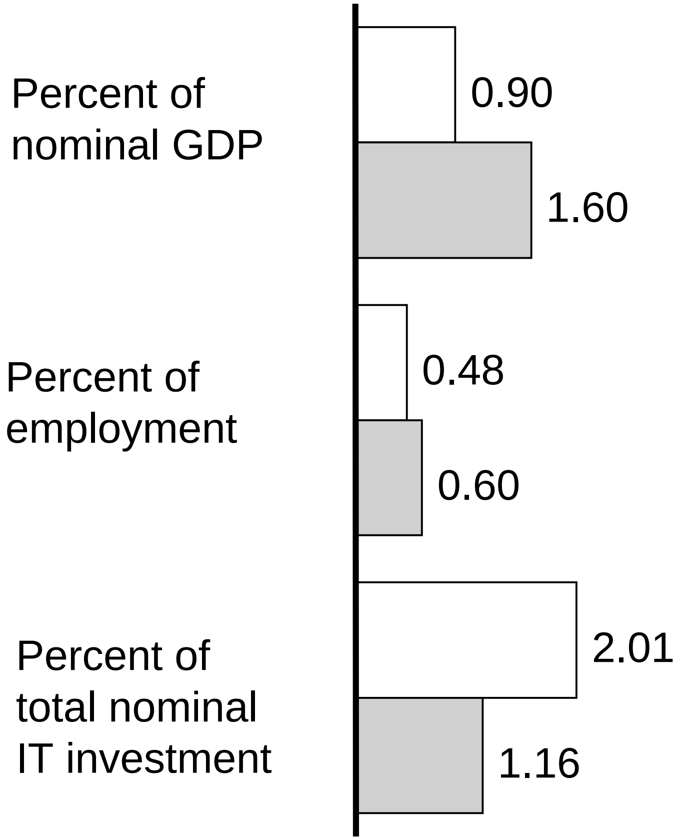
Exhibit 1

SECURITIES INDUSTRY SMALL, BUT A MAJOR CONTRIBUTOR TO OVERALL PRODUCTIVITY ACCELERATION

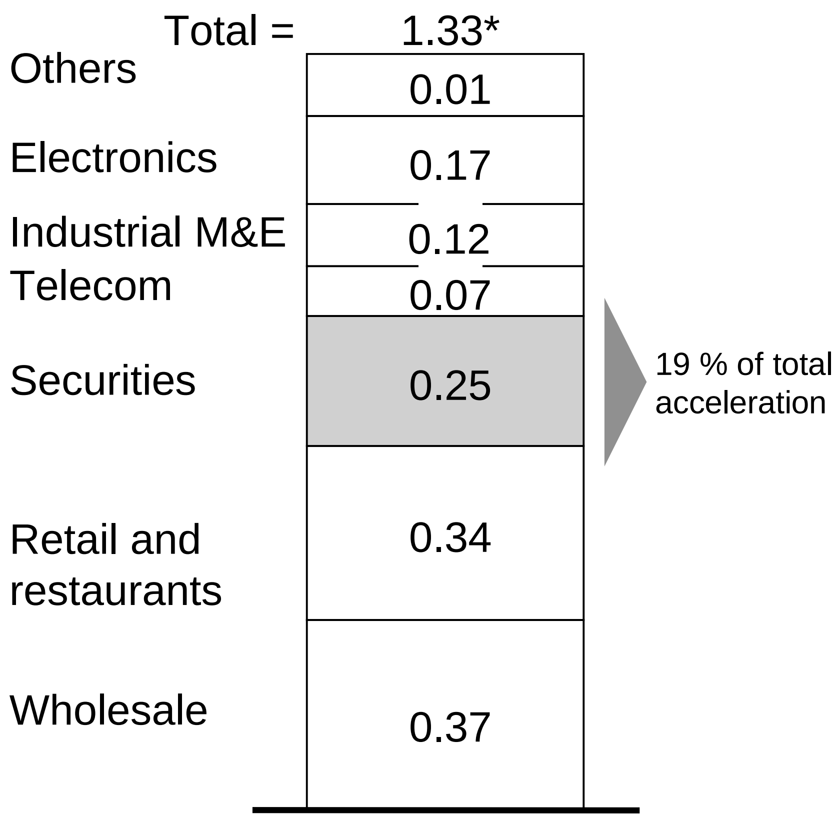
Percent



Securities industry as a share of overall economy



Contribution to the overall productivity acceleration, BEA data



* Excludes the contribution of farms and government

Source: BEA; MGI analysis

Exhibit 2

MGI STUDIED THE PORTION OF THE SECTOR WITH VAST MAJORITY OF ITS REVENUES

Percent

Focus of MGI analysis

Securities and commodity brokers, dealers, exchanges, and services (Major SIC group 62)

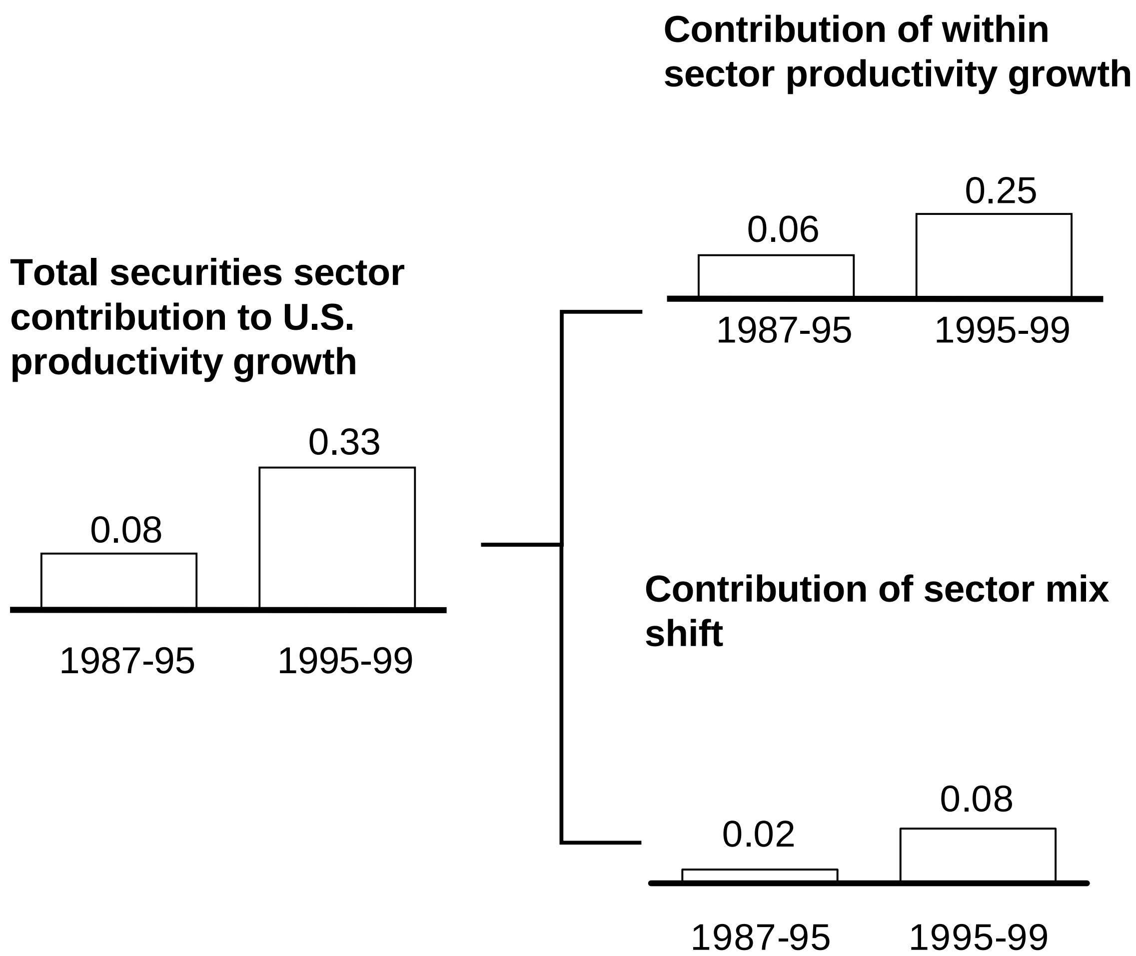
SIC sub-sector	Percent of total revenue as of 1997	Major business lines	Example companies
6211: Securities brokers, dealers, and flotation	72.2	• Securities underwriting and private placement • M&A deal making • Securities brokerage and dealing, e.g., equity brokerage, bond dealing • Margin lending • Distribution of mutual fund shares	• Bear Stearns • Goldman Sachs • Morgan Stanley • Merrill Lynch • Charles Schwab
6282: Investment advice	23.5	• Portfolio management • Investment advice	• Fidelity Investments • Putnam Investments
All others	3.6	• Commodity contracts trading and dealing (6221) • Securities and commodity exchanges (6231) • Other services, e.g., custodian and securities transfer, investment information services (6289)	• NYSE • NASDAQ • AMEX • Bloomberg • A-Mark Financials • DTC

Source: Census; MGI analysis

Exhibit 3

SECTOR CONTRIBUTION TO AGGREGATE JUMP CAME FROM WITHIN SECTOR GROWTH INCREASE AND SECTOR MIX SHIFT

CAGR, Percent

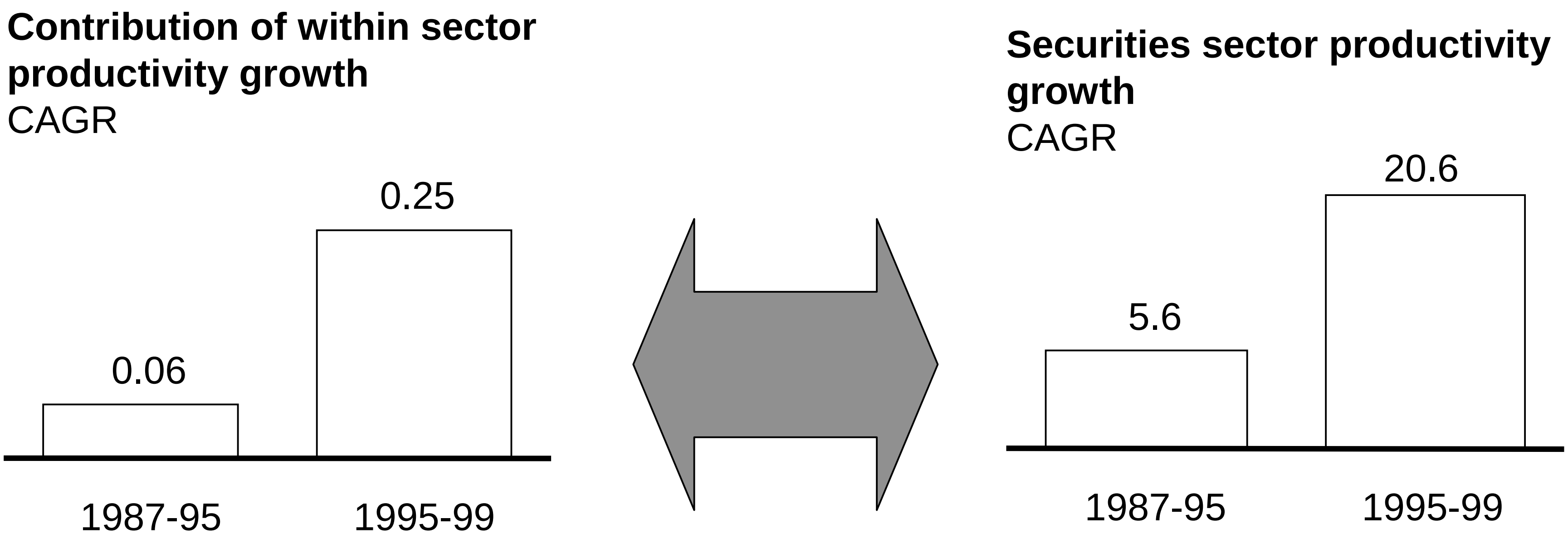


Source: BEA; MGI analysis

Exhibit 4

PRODUCTIVITY GROWTH WITHIN SECURITIES CONTRIBUTED SIGNIFICANTLY TO AGGREGATE PRODUCTIVITY GROWTH

Decomposition of securities sector contribution based on BEA value-added data

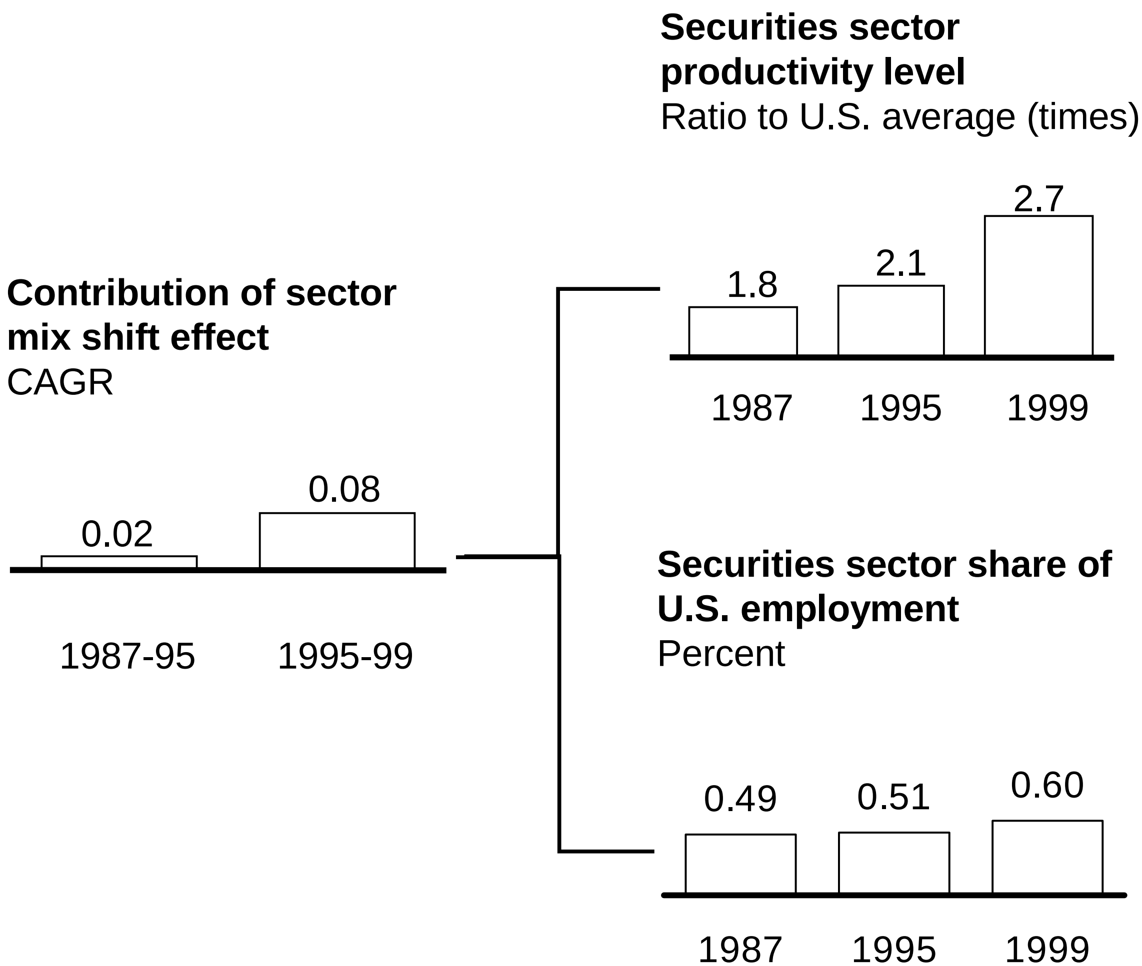


Source: BEA; MGI analysis

Exhibit 5

A COMBINATION OF HIGH PRODUCTIVITY LEVELS AND AN INCREASING SHARE OF EMPLOYMENT LED TO A MIX SHIFT CONTRIBUTION FOR THE SECURITIES SECTOR

Percent



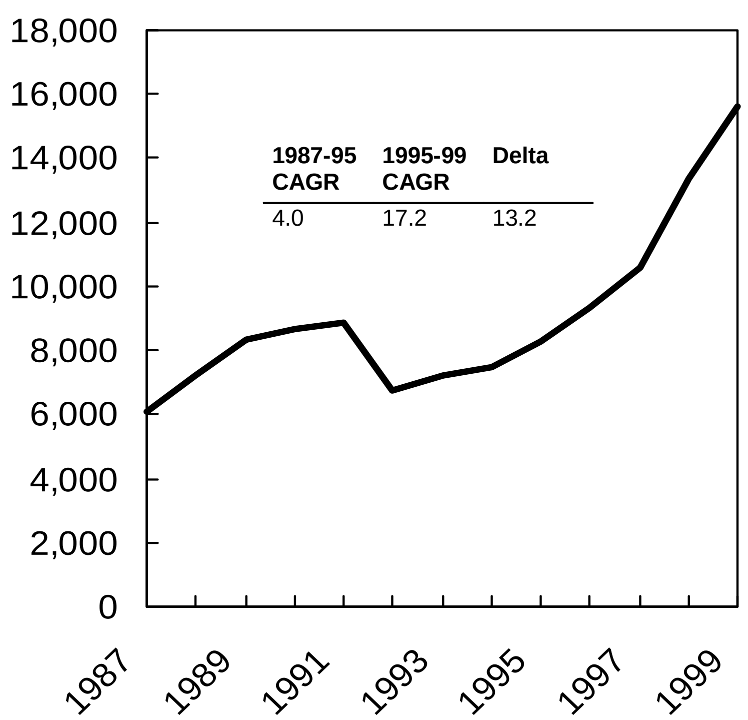
Source: BEA; MGI analysis

Exhibit 6

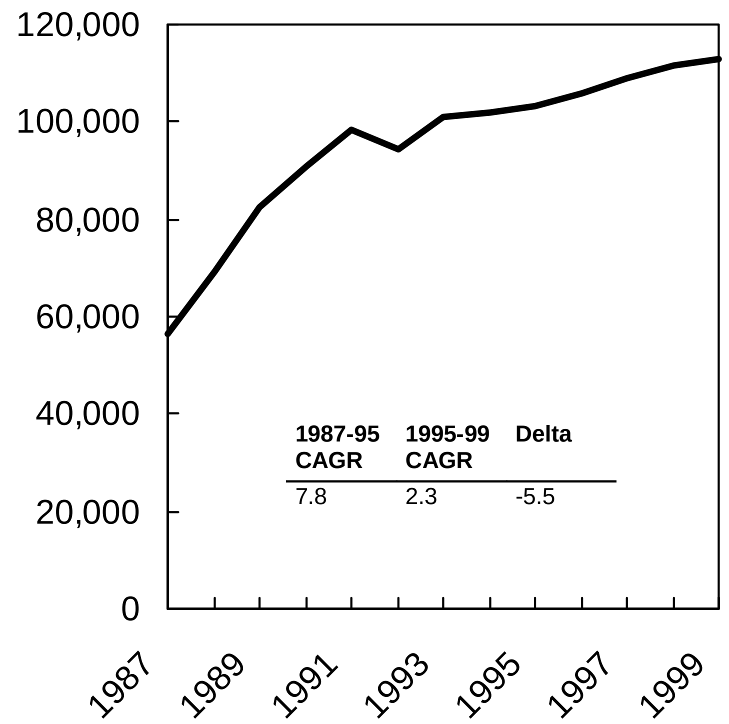
THE SECURITIES SECTOR'S FOCUS OF CAPITAL INVESTMENT SHIFTED TOWARDS IT CAPITAL DURING 1995-99

$ thousands per employee

IT capital intensity



Total capital intensity

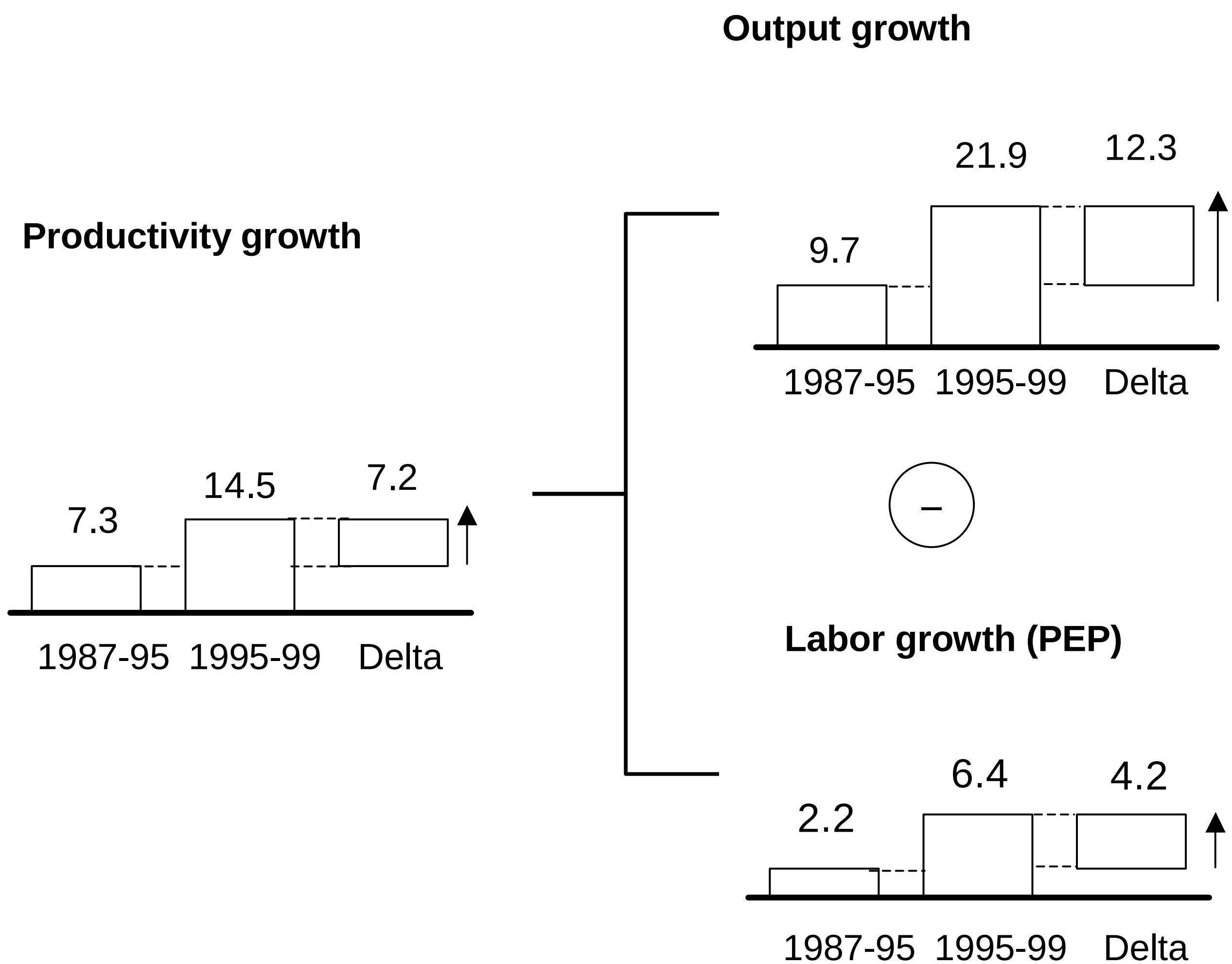


Source: BEA; MGI analysis

Exhibit 7

MGI LABOR PRODUCTIVITY MEASURE SHOWED SIGNIFICANT LABOR PRODUCTIVITY JUMP

Percent

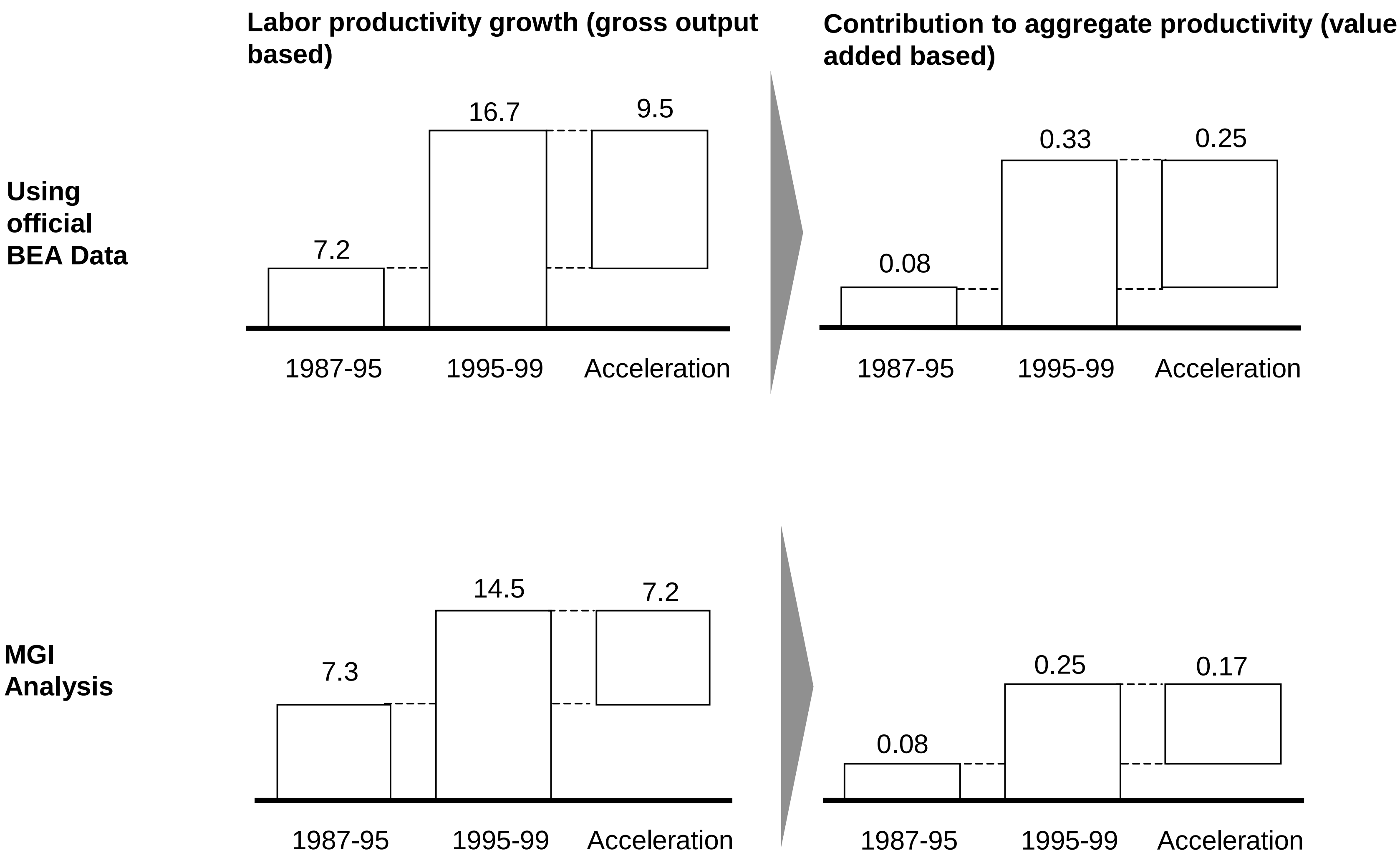


Source: BEA; McKinsey analysis

Exhibit 8

MGI'S RESULTS BROADLY CONSISTENT WITH AND SLIGHTLY LESS THAN THOSE BASED ON BEA DATA

CAGR, percent

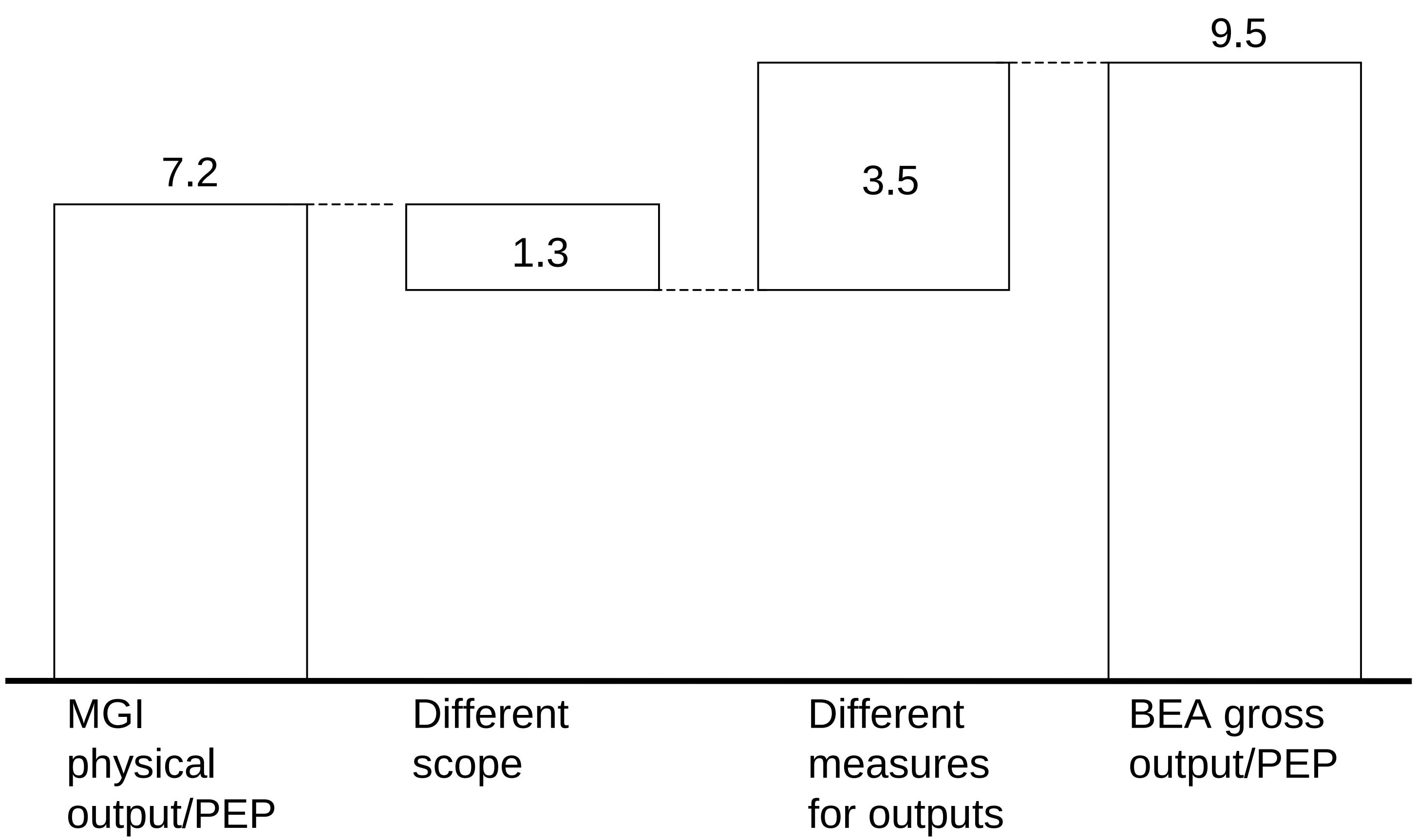


Source: BEA; SEC; SIA; ICI; MGI analysis

Exhibit 9

MGI'S RESULTS DIFFERED FROM THOSE BASED ON BEA DATA MOSTLY DUE TO IMPROVEMENT ON OUTPUT MEASURES

Percent



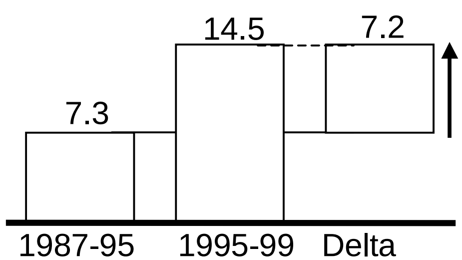
Source: BEA; MGI analysis

Exhibit 10

TWO SUBSECTORS WITHIN SECURITIES HAVE DIFFERENT PRODUCTIVITY PERFORMANCE*

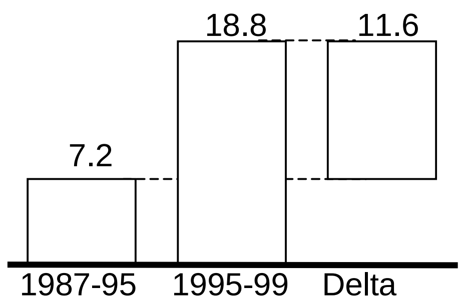
CAGR, percent

Securities sector

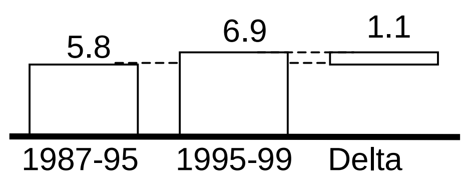


Subsector	Business activities	Contribution to output growth jump	Share of 1999 employment
Securities brokers and dealers	• Equity trading	53	77
	• Fixed-income securities trading	1	
	• Option trading	4	
	• Margin lending	6	
	• Distribution of mutual fund shares	14	
	• Investment banking services	22	
	Total	100	
Portfolio management	• Mutual fund management	62	23
	• Pension fund management	22	
	• High-net-worth individual account management	16	
	Total	100	

Securities brokers and dealers



Portfolio management



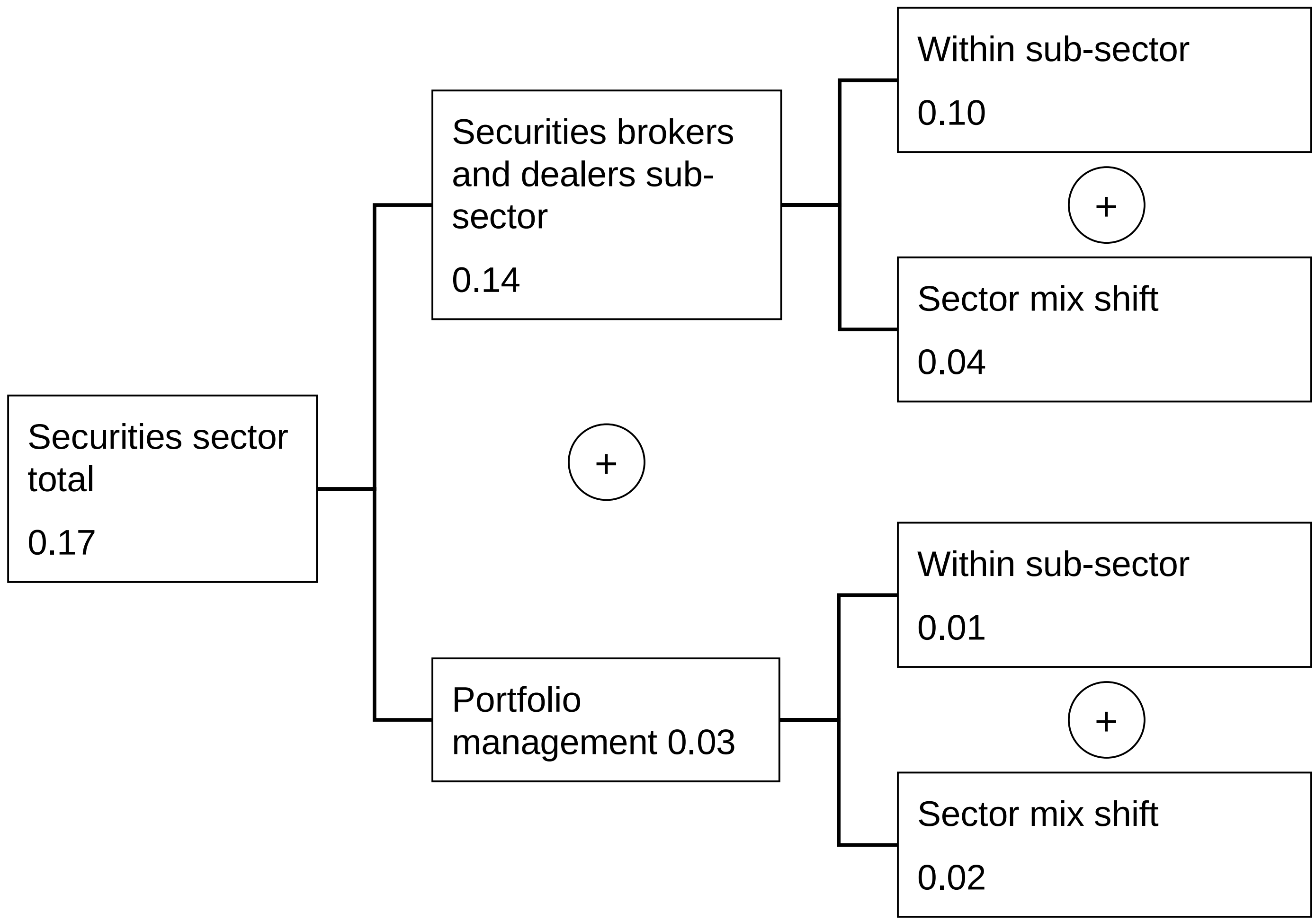
* Based on MGI measure

Source: BEA; BLS; SEC; SIA; ICI; MGI analysis

Exhibit 11

TWO SUB-SECTORS HAVE VERY DIFFERENT CONTRIBUTIONS TO THE AGGREGATE LABOR PRODUCTIVITY JUMP

Percent

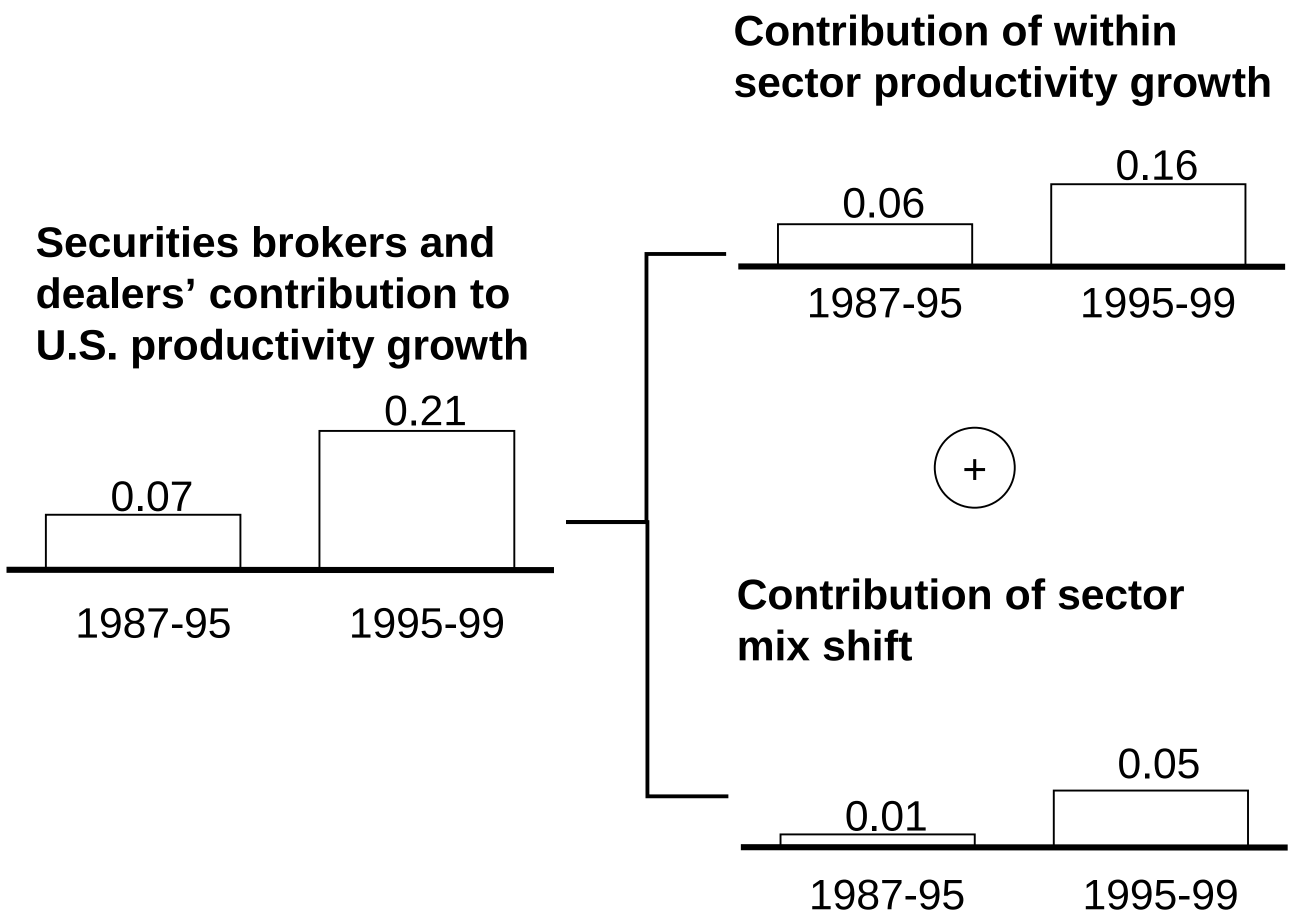


Source: BEA; MGI analysis

Exhibit 12

SECURITIES BROKERS AND DEALERS' CONTRIBUTION WAS MOSTLY CAUSED BY SIGNIFICANT WITHIN SECTOR PRODUCTIVITY GROWTH

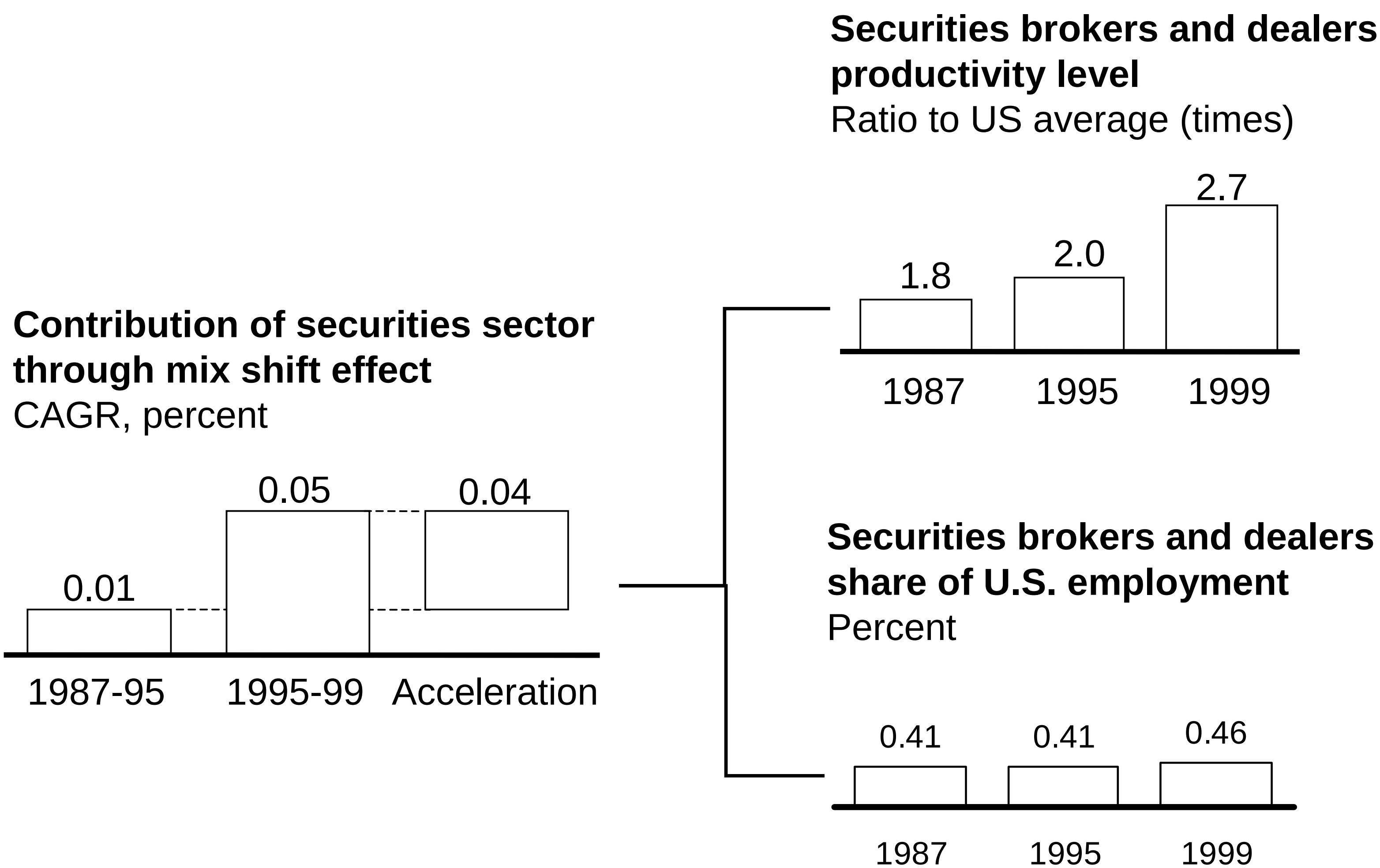
CAGR, percent



Source: BEA; MGI analysis

Exhibit 13

HIGH PRODUCTIVITY LEVELS AND GROWING SHARE OF EMPLOYMENT CAUSED SECTOR SHIFT MIX CONTRIBUTION

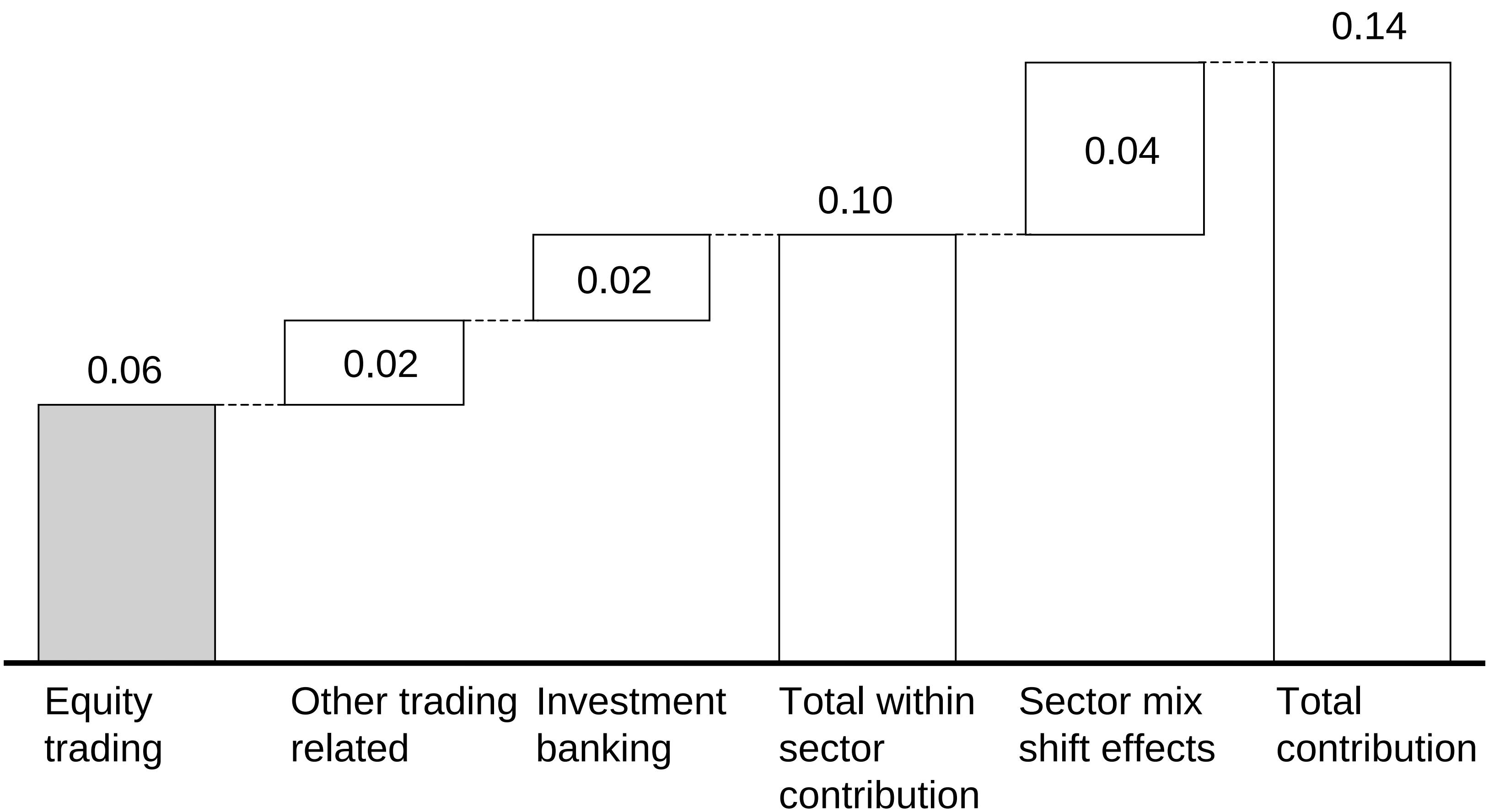


Source: BEA; MGI analysis

Exhibit 14

EQUITY TRADING IS THE BIGGEST CONTRIBUTOR TO THE WITHIN SECTOR PRODUCTIVITY JUMP

CAGR, percent



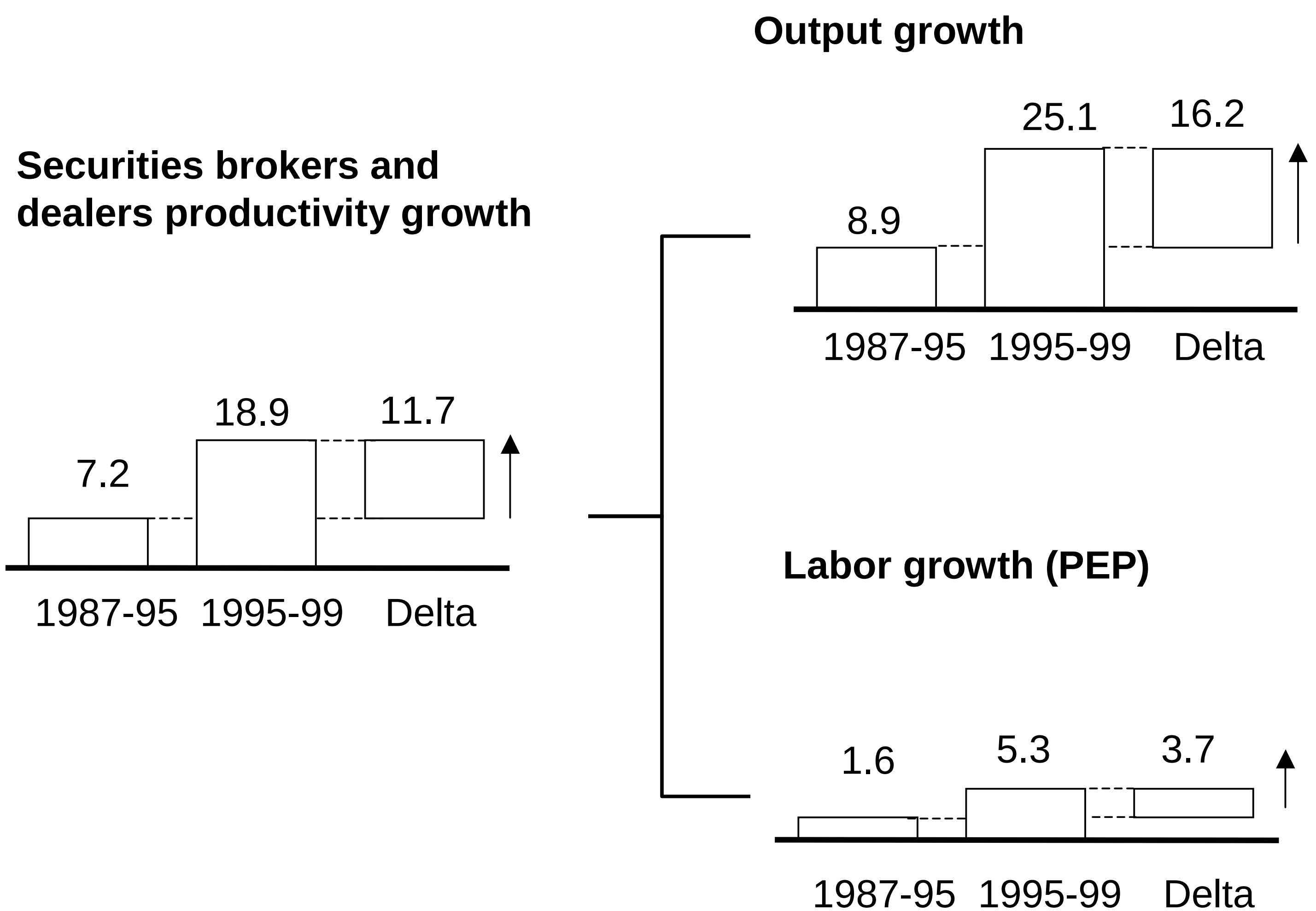
* Based on output contribution adjusted for estimated fixed labor proportion and level of process automation

Source: BEA; MGI analysis

Exhibit 15

HIGH OUTPUT GROWTH JUMP AND SLIGHT EMPLOYMENT GROWTH INCREASE LED TO SIGNIFICANT LABOR PRODUCTIVITY GROWTH JUMP

CAGR, percent



Source: BEA; MGI analysis

Exhibit 16

CAUSALITY SUMMARY FOR TRADING PRODUCTIVITY GROWTH ACCELERATION

Important (>50% of acceleration)

Somewhat important (10-50% of acceleration)

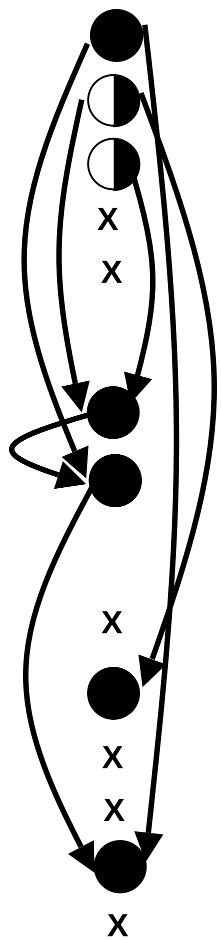
Not important (<10% of acceleration: asterisk to right indicates significant negative)

External factors
- Demand factors (Macro-economic/financial markets)
- Technology/innovation
- Product market regulation
- Up- /downstream industries
- Measurement issues

Industry dynamics
- Competitive intensity
- Prices/demand effects

Firm-level factors
- Output mix
- Capital/technology/capacity
- Intermediate inputs/techn.
- Labor skills
- Labor economies of scale
- OFT/Process design

Assessment



Comments

- Positive stock market cycle contributed to the surge of trading volume, and allowed achievement of labor economies of scale and lower trading costs
- IT dramatically increased equity trading capacity and enabled the entrance of online brokers
- Order handling rules and the SEC's 16th rules promoted competition on the NASDAQ
- Competitive intensity – online brokers and ECNs drove down equity trading charges
- Low equity trading charges led to large trading volumes, thereby, enabling the achievement of labor economies of scale
- The Internet and further automation
- High fixed labor structure thanks to IT investments

Source: MGI analysis

Exhibit 17

EQUITY TRADING – SUMMARY OF OPERATIONAL DRIVERS

Operational driver	Determinant factors	Percentage contribution to equity trading productivity jump
Labor economies of scale – "free" productivity growth due to output growth	• Output growth rate • Percentage of fixed labor as a result of pre-1995 IT investment (old IT)	50
Labor substitution **• Retail online trading** **• Increasing automation of other trading processes**	• Automation of retail customer interface • Online trading volume • Labor savings per trade	10
	• Adoption of both new IT and old IT, e.g., – Wholesale customer interface automation – Increasing penetration of straight-through-process (STP)	40

Source: BEA; BLS; SEC; SIA; company reports; interviews; MGI analysis

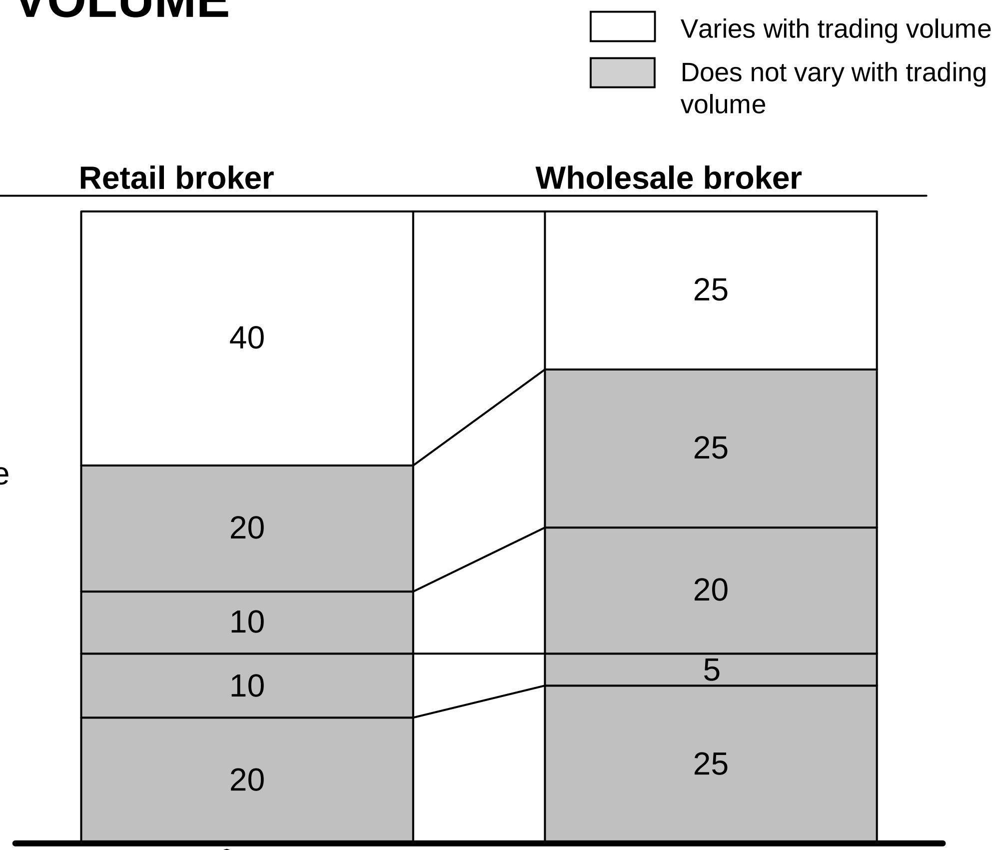
Exhibit 18

MORE THAN HALF OF EMPLOYMENT IN EQUITY TRADING DOES NOT VARY WITH TRADING VOLUME

Percent, 1999

ILLUSTRATIVE

Functions	Driver of labor growth
Front office • Registered representatives • Customer service reps	• Number of trades • To a lesser extent - number of accounts
Back office operations	• Small portion varies with trade volume, others are fixed
IT	• Level of automation • Product varieties
Account management	• Number of accounts
Other supporting functions	• Size and complexity of the organization



"40% of our cost is driven by trades volume and 30% is driven by number of accounts"
– Retail broker

"If volume doubles, I only need to add 30% more people"
– MD of major wholesale broker

Source: Interviews; MGI analysis

Exhibit 19

HIGH LEVEL OF FIXED LABOR LED TO LABOR PRODUCTIVITY GROWTH JUMP WHEN OUTPUT SURGED

1987-1995

- Output growth CAGR 13.3%
- 65% fixed labor in 1987

→ 6.8% productivity growth

1995-1999

- Output growth CAGR 39.5%
- 65% fixed labor in 1995

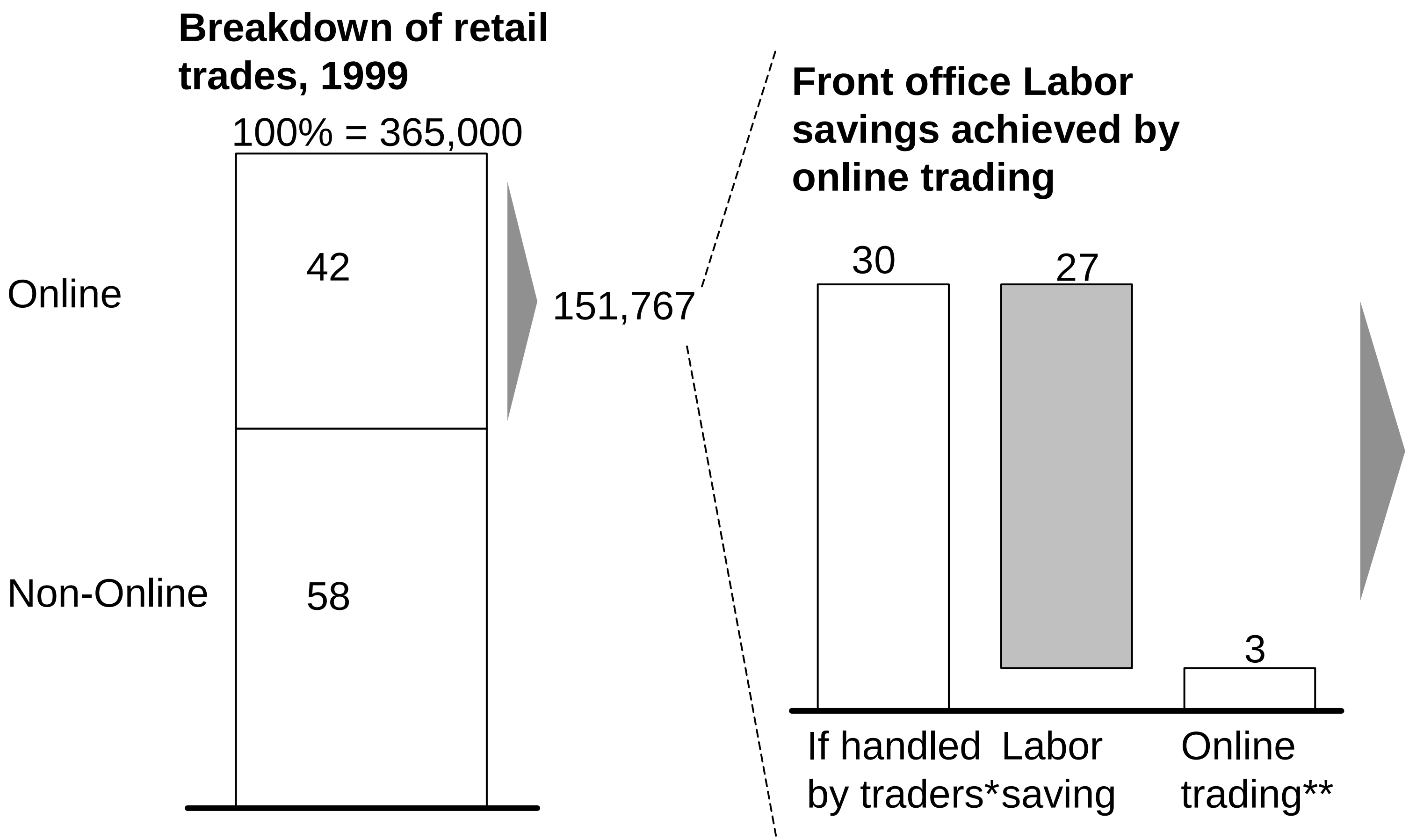
→ 17.7% productivity growth

Labor economies of scale contribute to half of equity trading productivity jump

Source: BLS; BED; SEC; SID; MGI analysis

RETAIL ONLINE TRADING CONTRIBUTED TO LABOR PRODUCTIVITY JUMP THROUGH LABOR SAVING

Thousands



- **Labor saving from online trading accounts for 10% of equity trading productivity jump**

* Assume average trader executes 20 trades per day
** Include website administration, content editing and additional IT staff

Source:Company reports; interviews; MGI analysis

Exhibit 21

CONTINUOUS AUTOMATION HAS BEEN SUBSTITUTING IT FOR LABOR FOR DECADES

	Back-office automation	**Platform integration**	**Front office automation**
Focus of IT investment	• Isolated back-office automation • Infrastructure automation, e.g., clearance	• Product-focused automation • Integration of back-office functionalities • Integration with front office	• Online trading for retail; direct link for institutional clients • Straight-through-process (STP) • Automation of inter-dealer markets • Automation of cross-boarder trading
Key technology	• Mainframe	• Client-server architecture	• Network based technologies
Impact on productivity	• Replace back-office labor with computer • Increase back-office capacity	• Increase capacity for all products • Scalable platform • Continue substituting labor	• Dramatically increase overall capacity • Reducing sales and trading labor
	80's	Early 90's	Late 90's and beyond

Source: Company interviews; MGI analysis

Exhibit 22

OVER-CONFIDENT ONLINE TRADERS GENERATED EXCESSIVE TRADING VOLUME DURING THE BULL MARKET

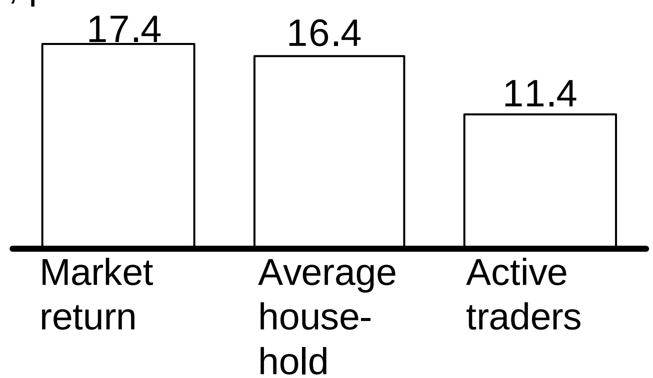
Factors causing over-confidence

- Position effect – selling winners during the bull market but holding losers after the crash
- Self-bias – over-confidence in one's own trading skills
- House-money effect – high returns from the market leads to reckless trading activities
- Attention effect – bull market catches more attention, leading to more trades
- Trading for entertainment, especially online trading
- Feeling of empowerment because of online trading

Impact

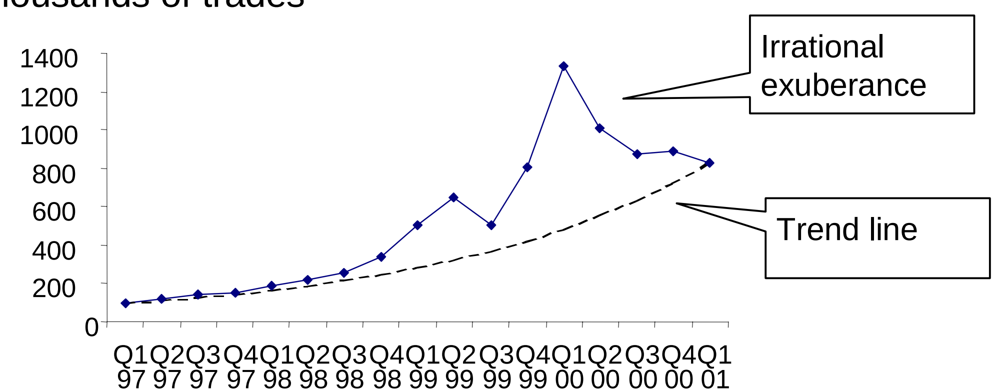
Trading returns*

Percent, pre-tax



Online trading volume

Thousands of trades



* Based on research on 66,465 households during 1991-1996; Brad M. Barber and Terrance Odean, "Trading is Hazardous to Your Wealth: The Common Stock Investment Performance of Individual Investors," *The Journal of Finance* Vol No. 2, April 2000

Source: Barber and Orden research; Interviews; NASDAQ; NYSE; MGI analysis

Exhibit 23

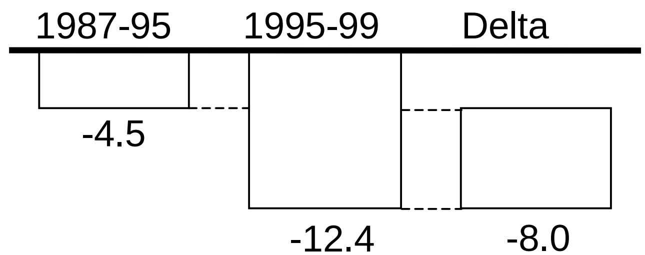
AN ACCELERATION IN THE DECLINE OF TRADING CHARGES ALSO CONTRIBUTED TO THE TRADING VOLUME GROWTH ACCELERATION

Factors

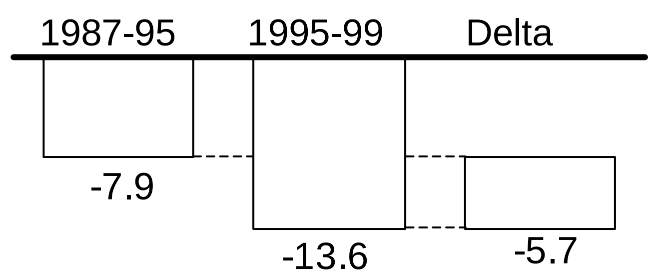
- Intensive competition from new online brokers accelerated retail trading charges decline
- New SEC regulations promoted competition and lowered spread costs
  – Order Handling Rules* in 1997 facilitates the in-roads of ECNs
  – 16th rule** reduces the quote spread on both the NASDAQ and NYSE
- Automation enabled decline of marginal cost per trade while volume grew
- Brokers offered volume discount to institutional investors

Impact
CAGR, percent

Average equity trade charge as percent of dollar volume



Average equity trade charge per trade



* Included two parts: SEC Rule 11 Ac 1-4 requires NASDAQ market makers to display public limited orders; SEC Rule 11Ac 1-1 requiring that market makers may not post one quote on NASDAQ and a different quote on ECNs

** Reduced quotation tick-size from 1/8 to 1/16

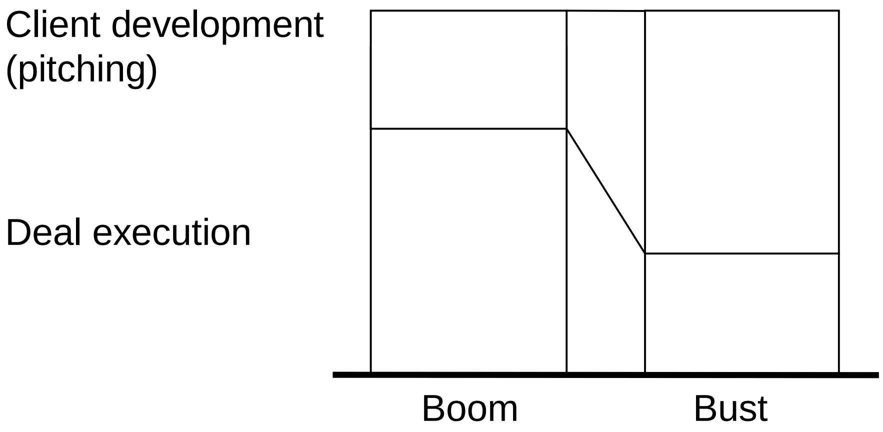
Source: SEC; NYSE; NASDAQ; SIA; MGI analysis

DCO-ZYJ611/011003DexPP1

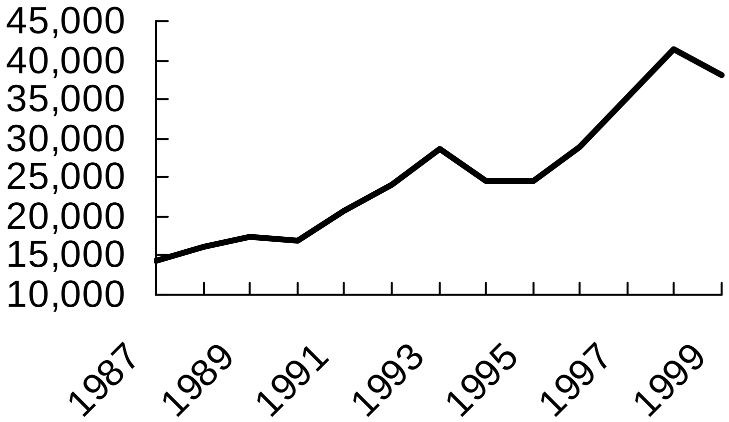
Exhibit 24

INVESTMENT BANKS ACHIEVED PRODUCTIVITY ACCELERATION BY LEVERAGING LABOR UTILIZATION

Conceptual typical time allocation of investment bankers



Total number of underwriting and M&A deals



Increased labor utilization by increasing “executing time” to “pitching time” ratio during the boom

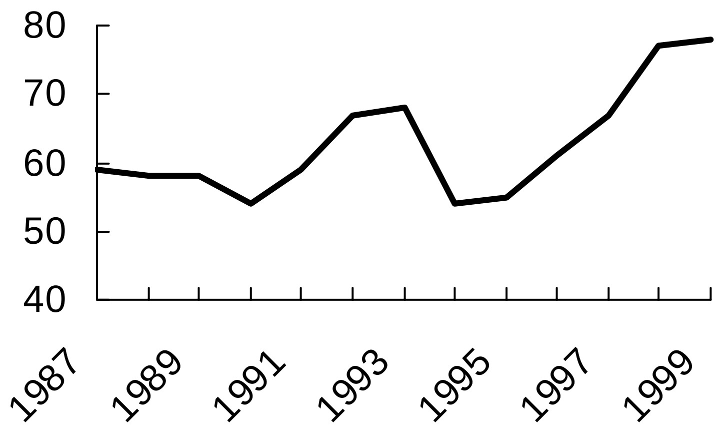
Source: Company interviews; SIA; MGI analysis

Exhibit 25

THE BULL MARKET FUELED INVESTMENT BANKING OUTPUT ACCELERATION WITHOUT REQUIRING ADDITIONAL LABOR

$ Millions

Average deal size of underwriting



Average M&A deal size

Investment banks increased labor productivity by doing bigger deals during bull market, 1995-99

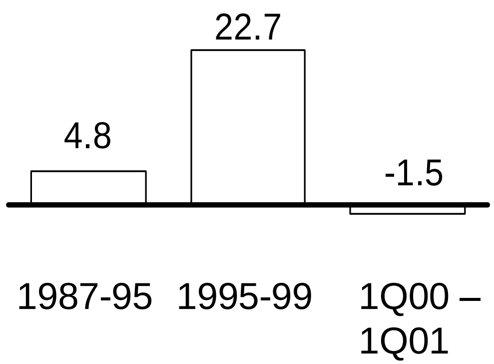
Source: Company interviews; SIA; MGI analysis

Exhibit 26

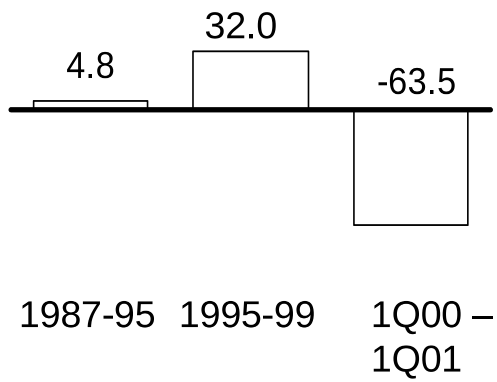
OUTPUT FOR INVESTMENT BANKING AND OTHER TRADING RELATED ACTIVITIES IS CLOSELY RELATED TO STOCK MARKET CYCLES

CAGR, percent

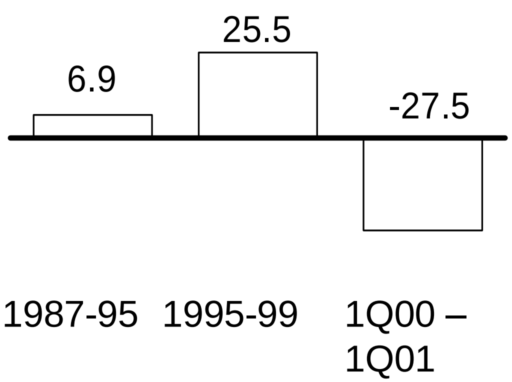
Securities underwriting



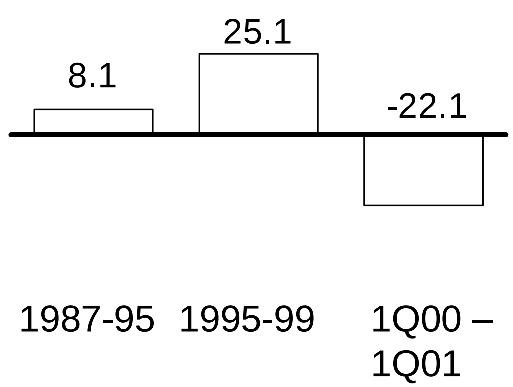
M&A



Margin lending



Distribution of mutual funds



The output growth jump of investment banking and other trading-related activities disappeared after the stock market correction in 2000

Source: SIA; ICI; SEC; NYSE; NASDAQ; MGI analysis

Exhibit 27

MOST OF THE PRODUCTIVITY GROWTH ACCELERATION IN EQUITY TRADING IS SUSTAINABLE OVER THE NEXT 5 YEARS

Percent

		Sustainability over next 5 years	Rationale
Labor economies of scale	50	25	• The trends of moving toward an equity economy will continue • Equity trading volume will maintain 15-20% annual growth rates primarily due to continuously falling trading charges • However, the hyper growth of online trading and margin lending during 1997-99 is not sustainable
Front-office automation through online trading	10	10	• The penetration rate of online trading as a share of total retail trading is expected to grow from 45% in 2000 to 70-80% by 2005
Other automations	40	40	• Numerous automation opportunities exist, e.g., – Penetration of wholesale front-office automation could increase from present 40% level to 80-90% – Automation of stock exchanges – Penetration of straight-through-process – Automation of inter-dealer market – Cross-border trading automation

Source: BEA; BLS; SIA; SEC; interviews; MGI analysis

Exhibit 28

EQUITY TRADING CHARGES ARE LIKELY TO DECLINE AT SIMILAR RATES OVER THE NEXT 5 YEARS

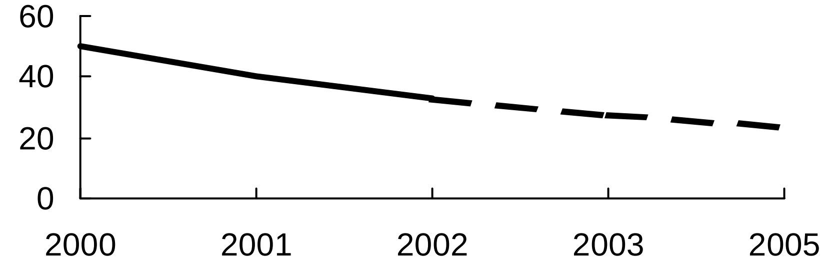
Sustainable factors

- True straight-through-process (no human touch) will further reduce variable cost per trade to negligible levels
- Discount brokers adding advice (e.g., Schwab) and full-service brokers going online (e.g., Merrill Lynch) will intensify competition and drive down retail commissions
- Decimalization and other pro-competition rules have been squeezing spread costs on the NASDAQ and the full effect will play out in the next few years
- Competition among NASDAQ, NYSE and ECNs will eventually drive down the commission rate for wholesale investors
- Growing popularity of new pricing strategies offering unlimited trading for a fixed fee will push the average trading charge decline even further

Impact on equity trading cost

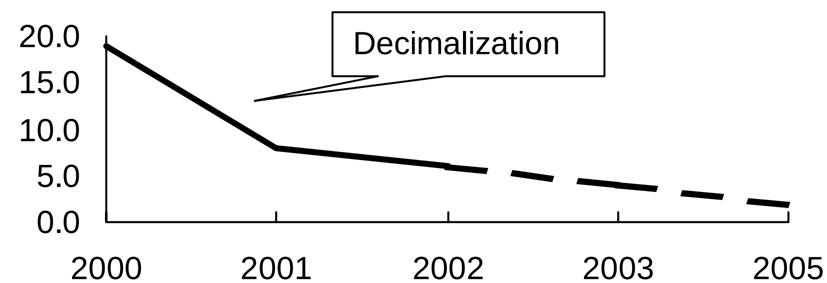
Retail commission rate projections

Dollars per trade



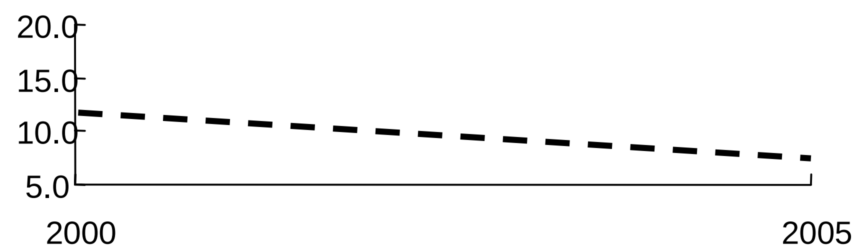
NASDAQ quoted spread

Cents per share



Wholesale investor trading commission

Cents per share (the same scale)



Source: NASDAQ; SIA; analyst reports; MGI analysis

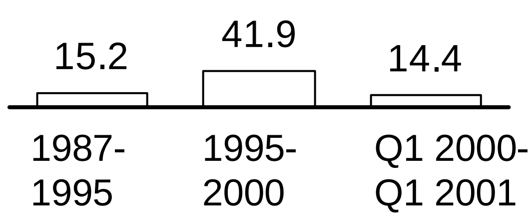
Exhibit 29

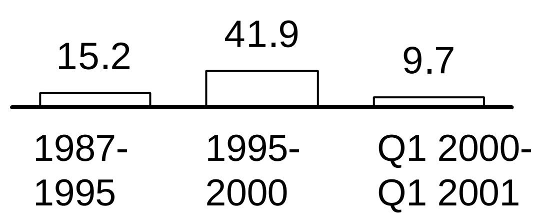
EXCLUDING ONE-TIME EVENTS, NUMBER OF EQUITY TRADES HAVE MAINTAINED ROBUST GROWTH AFTER STOCK MARKET CORRECTION

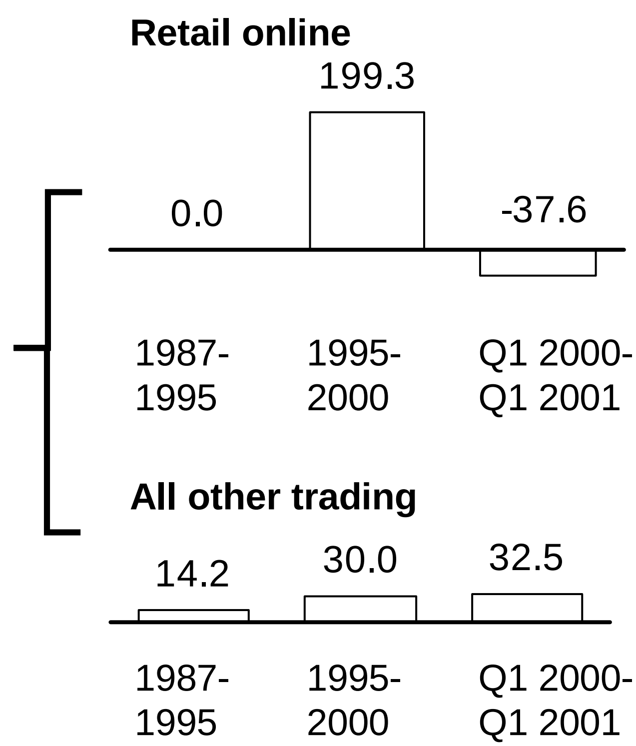
NYSE and NASDAQ, CAGR, percent

Adjustments

1. **Annualize 2001 trade volume and calculate growth rate, 2000-2001**
2. **Exclude impact of decimalization on NYSE 2001 volume***
3. **Excluding retail online exuberance**







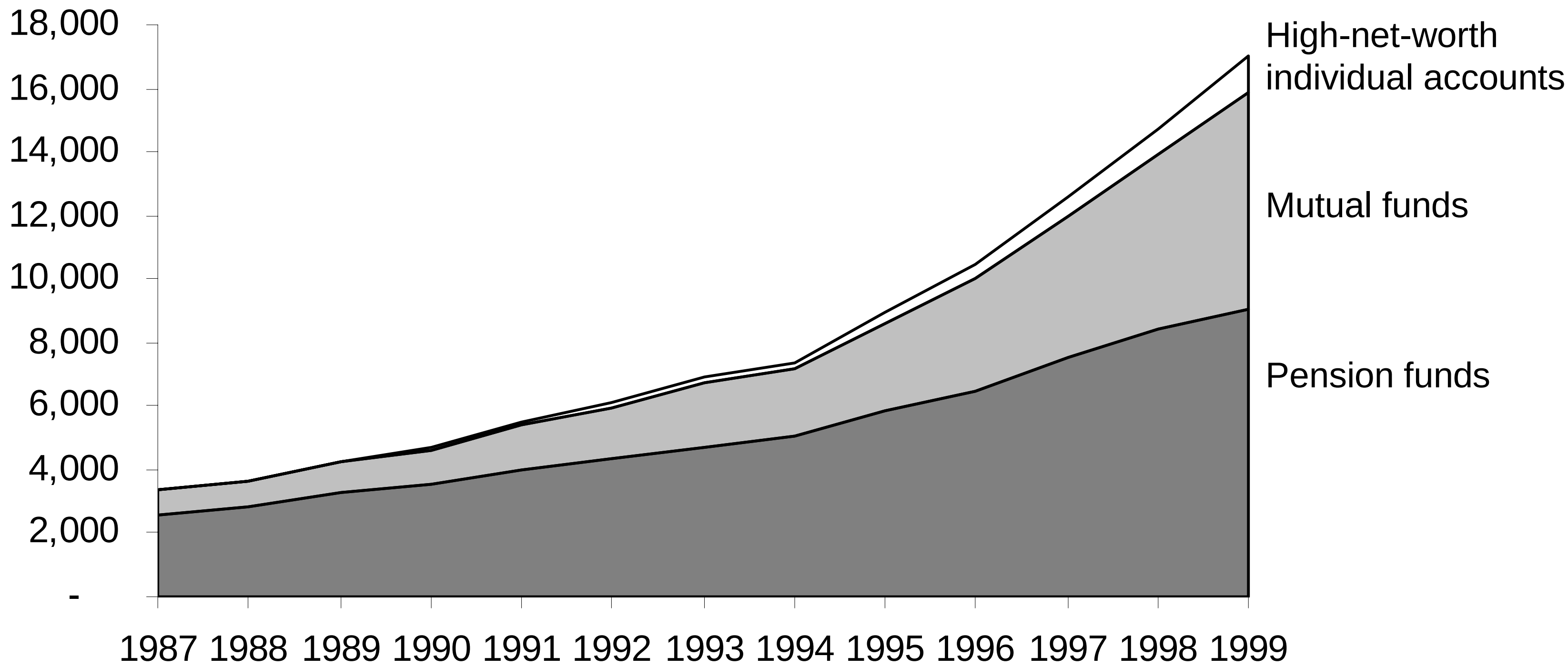
* Assuming trade size does not change from 2000-2001

Source: NASDAQ; NYSE; MGI

Exhibit 30

PORTFOLIO MANAGEMENT COMPANIES HAD MORE THAN $15 TRILLION ASSETS UNDER MANAGEMENT BY 1999

$ Billions

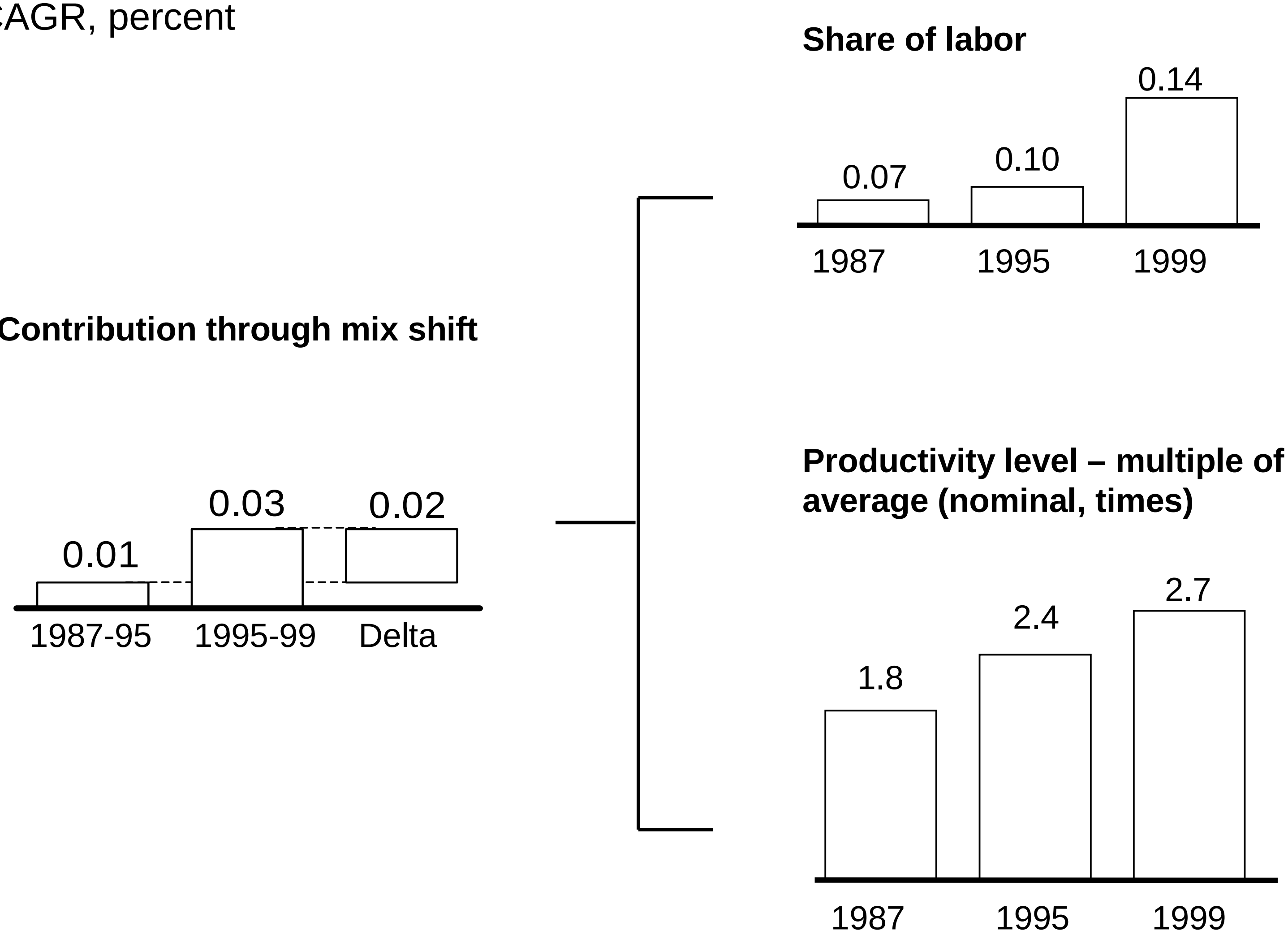


Source: ICI; MGI analysis

Exhibit 31

PORTFOLIO MANAGEMENT'S INCREASING EMPLOYMENT SHARE DROVE ITS SECTOR MIX SHIFT CONTRIBUTION

CAGR, percent

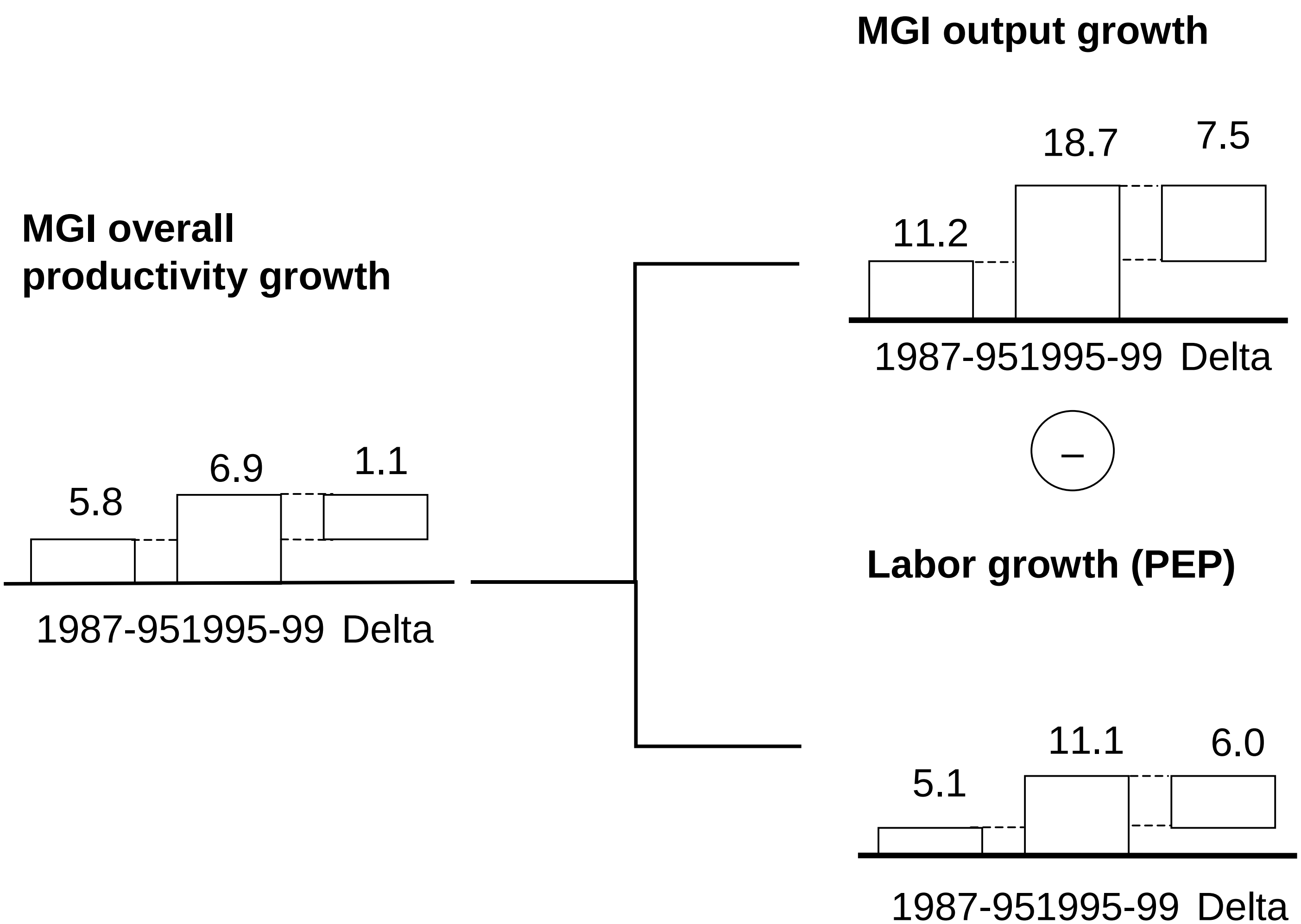


Source: BEA; BLS; ICI; MGI analysis

Exhibit 32

RAPID EMPLOYMENT GROWTH OFFSET THE PORTFOLIO MANAGEMENT OUTPUT JUMP

Percent

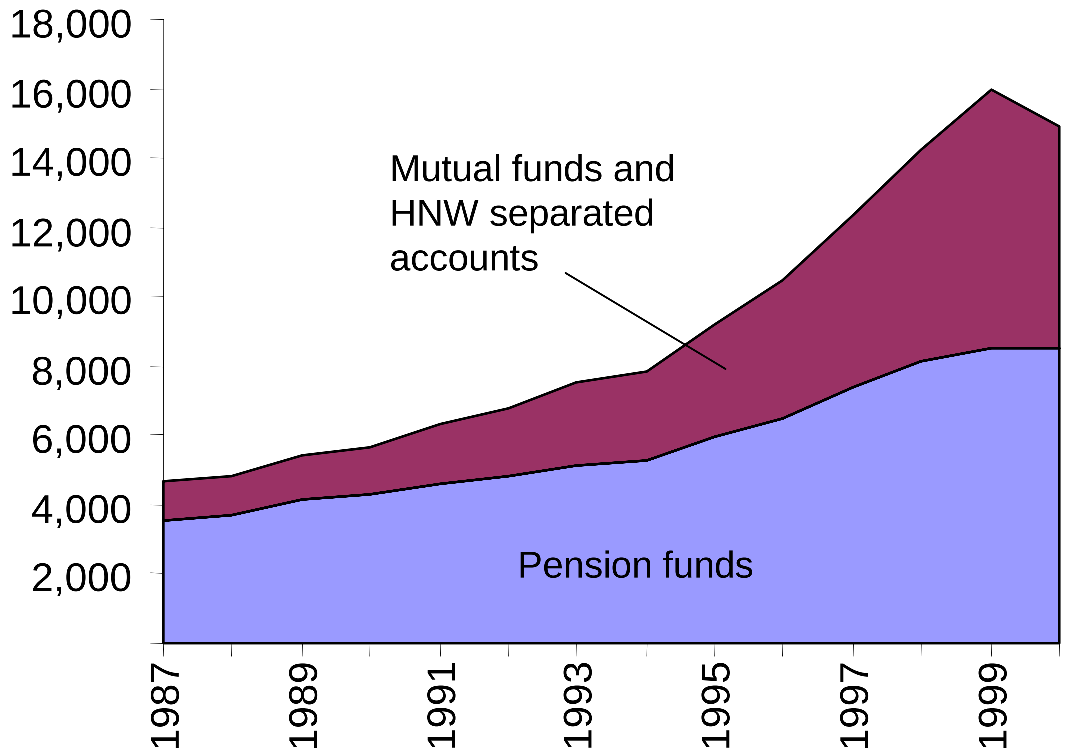


Source: BEA; MGI analysis

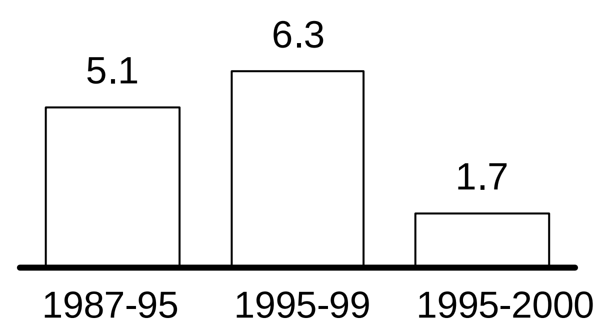
Exhibit 33

STRONG STOCK MARKET PERFORMANCE LED TO PORTFOLIO MANAGEMENT'S PRODUCTIVITY GROWTH JUMP

Assets under management
$ Billions



Portfolio management's productivity growth plummeted after the 2000 stock market correction
CAGR, percent

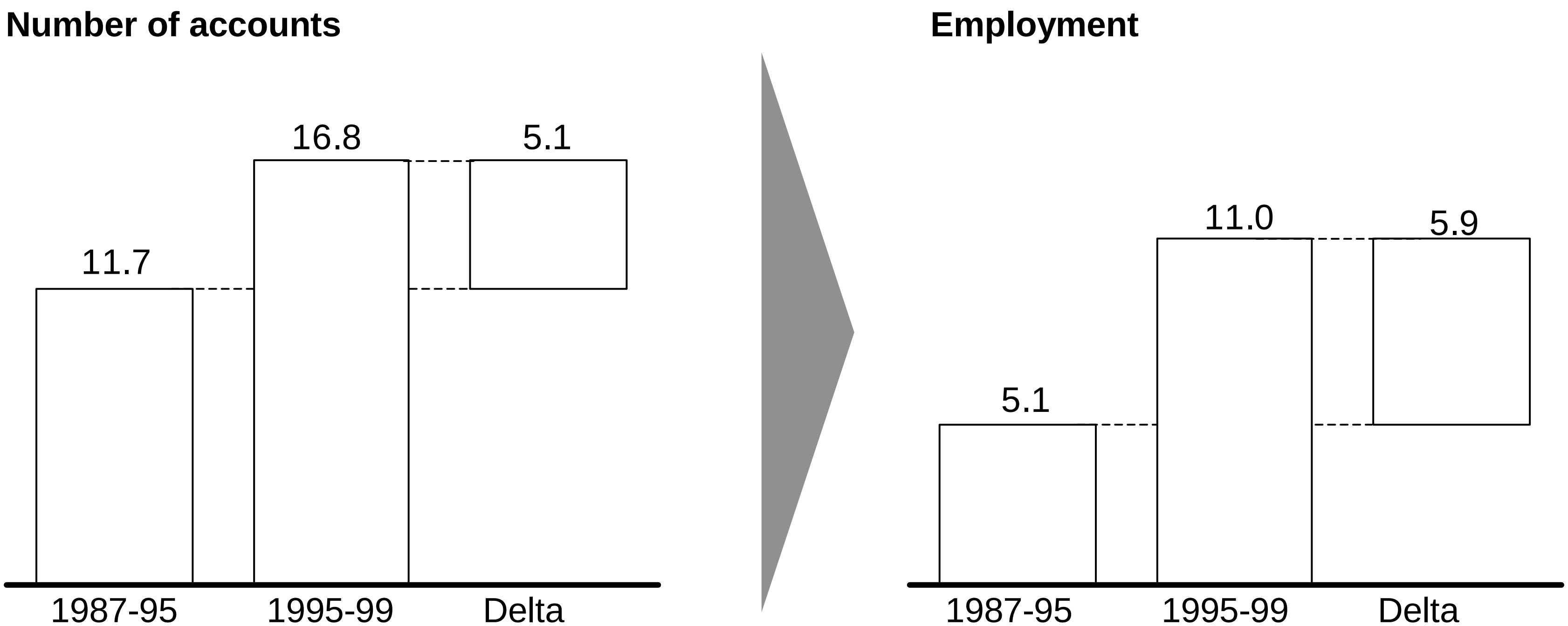


Source: ICI; MGI analysis

Exhibit 34

GROWTH IN THE NUMBER OF ACCOUNTS UNDER MANAGEMENT REQUIRED ADDITIONAL LABOR

CAGR, percent

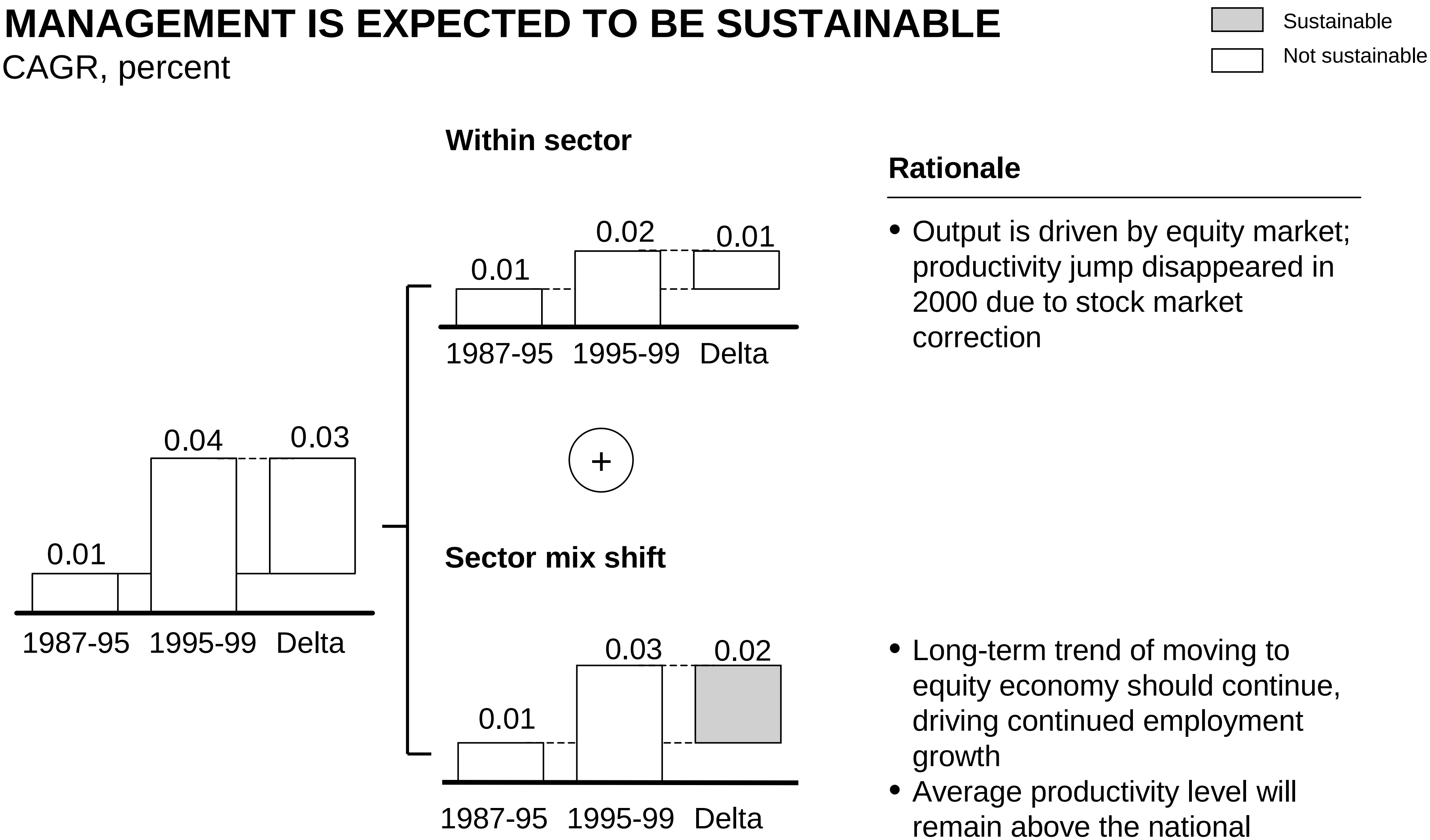


Source:BLS; ICI; MGI analysis

Exhibit 35

SECTOR MIX SHIFT CONTRIBUTION OF PORTFOLIO MANAGEMENT IS EXPECTED TO BE SUSTAINABLE

CAGR, percent



Rationale

- Output is driven by equity market; productivity jump disappeared in 2000 due to stock market correction

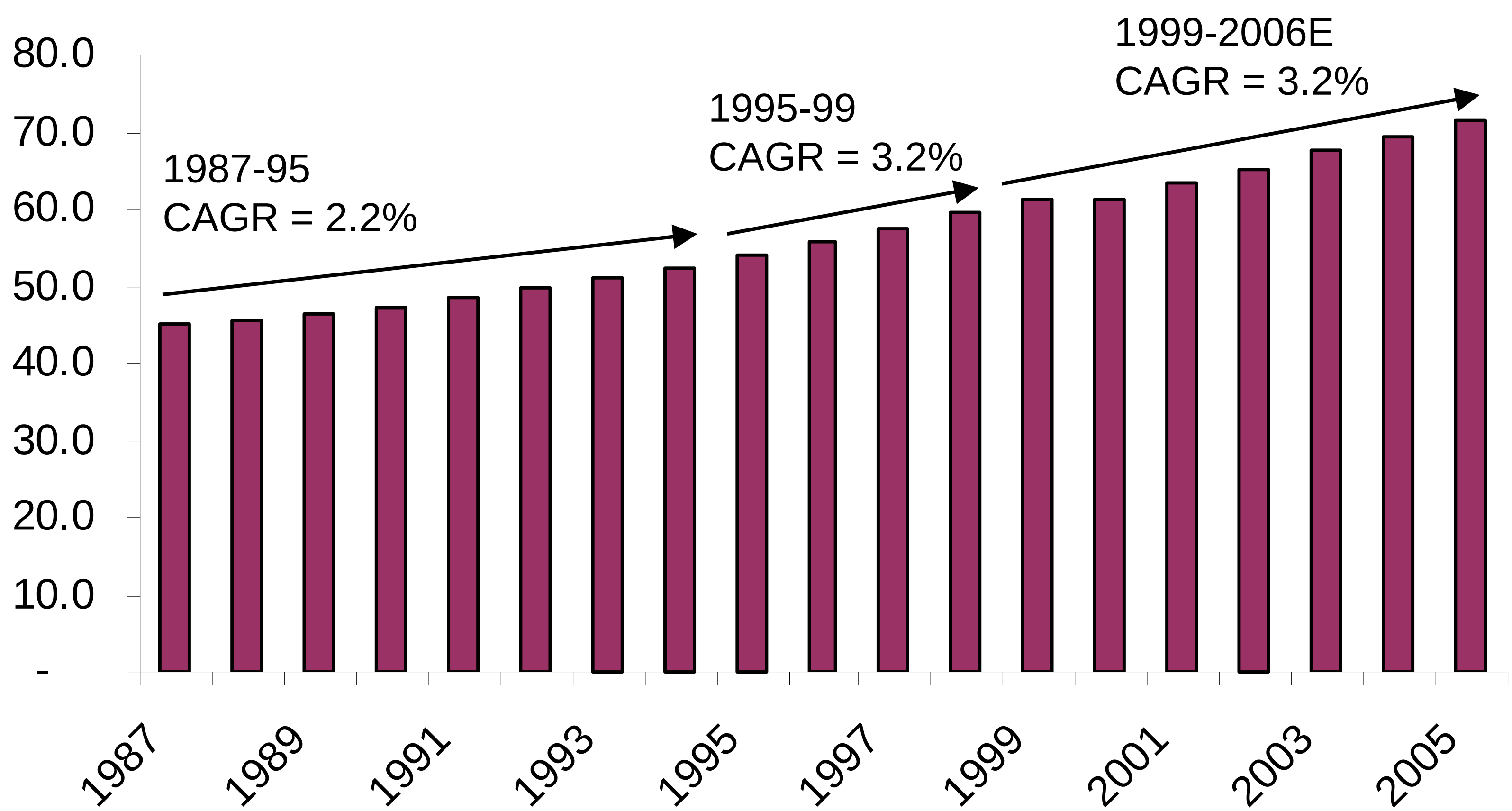
- Long-term trend of moving to equity economy should continue, driving continued employment growth
- Average productivity level will remain above the national average

Source:BEA; ICI; MGI analysis

Exhibit 36

AGING BABY BOOMERS WILL GENERATE HIGH DEMAND FOR PORTFOLIO MANAGEMENT SERVICES

$ Millions

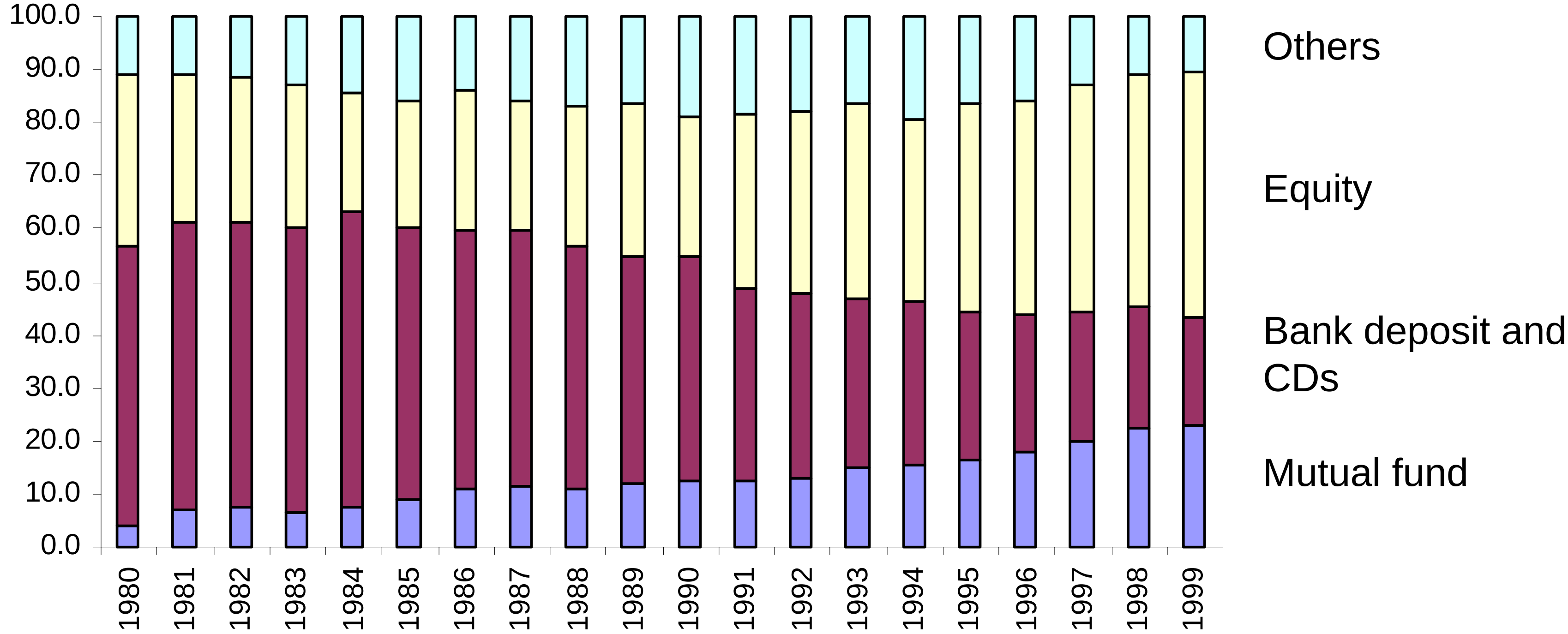


Source: Census; MGI analysis

Exhibit 37

MUTUAL FUNDS HAVE STEADILY INCREASED SHARE OF HOUSEHOLD FINANCIAL ASSETS OVER THE LAST TWO DECADES

Percent of U.S. household financial assets



Source: Federal Reserve; MGI analysis

Exhibit A1

COMPARISON OF MGI'S OUTPUT MEASURE AND BEA'S GROSS OUTPUT MEASURE

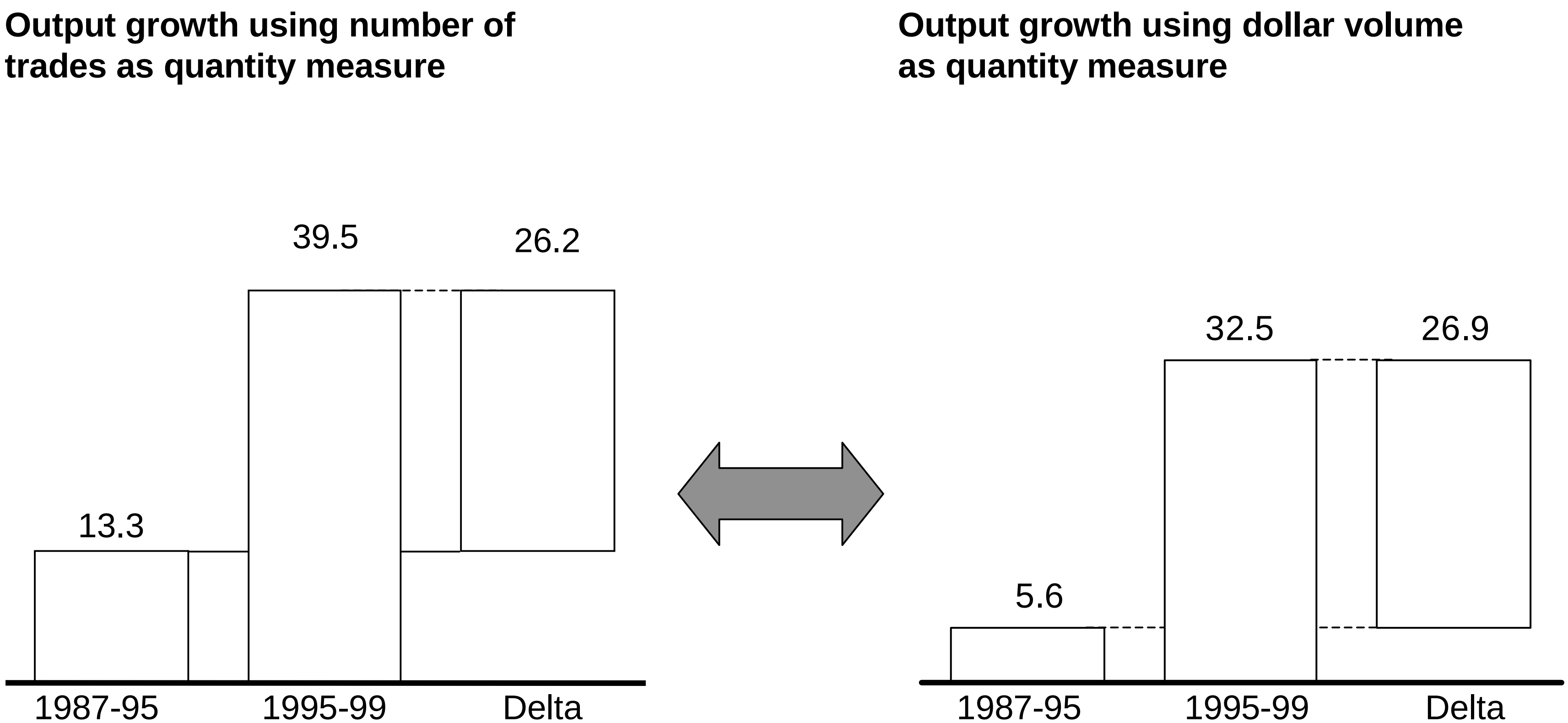
	Service line measured	MGI Output measure	BEA gross output measure
SIC 6211	Underwriting	Total dollar volume adjusted by GDP deflator	Revenue deflated by CPI
	M&A	Total deal dollar value adjusted by GDP deflator	Not individually measured
	Equity trading	Fisher index of number of trades of wholesale, full-service retail, non-online discount retail, and online retail trading	Number of trades
	Bond trading	Total trading dollar volume adjusted by GDP deflator	Revenue deflated by CPI
	Option trading	Number of option contracts traded	Revenue deflated by CPI
	Margin lending	Average lending balance adjusted by GDP deflator	Not measured
	Mutual fund distribution	New mutual fund sales adjusted by GDP deflator	Revenue deflated by CPI
SIC 6282	Portfolio management	Fisher index of assets under management adjusted by GDP deflator of mutual funds, pension funds, and high-net-worth separate accounts	Revenue deflated by CPI; not individually measured; revenue is implicitly extrapolated

Source: SEC; SIA; ICI; NASD; NYSE; Thomas Financial Securities data; BMA; MGI analysis

Exhibit A2

DOLLAR VOLUME AND NUMBER OF TRADES AS QUANTITY MEASURES FOR EQUITY TRADING YIELD SIMILAR OUTPUT GROWTH JUMPS

CAGR, percent

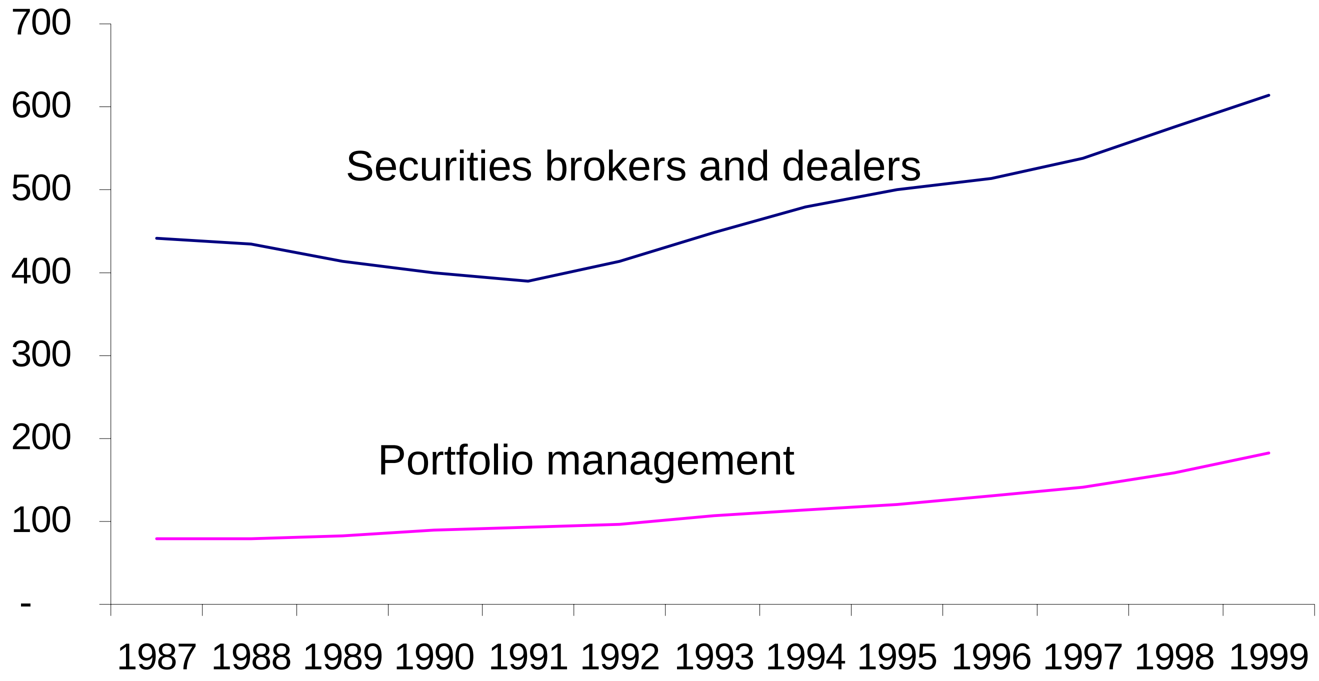


Source: BEA; BLS; SEC; SIA; ICI; MGI analysis

Exhibit A3

EMPLOYMENT IN SECURITIES BROKERS/DEALERS AND PORTFOLIO MANAGEMENT

Thousands workers



Source: BEA; BLS; MGI analysis

Exhibit A4

MGI METHODOLOGY COVERS MOST IMPORTANT BUSINESS LINES OF THE INDUSTRY

✓ Included
✗ Excluded

SIC 62: Security and commodity brokers and dealers	Included by BEA	Included by MGI	Comments
• 6211 Security brokers dealer and flotation company			
– Underwriting and private placement	✓	✓	Core business lines
– M&A	✓	✓	Core business lines
– Equity dealing and brokerage	✓	✓	Core business lines
– Bond dealing	✓	✓	Core business lines
– Option dealing	✓	✓	Core business lines
– Mutual fund distribution	✓	✓	Core business lines
– Account supervision, investment advisory, and administrative services	✓	✓	Covered by portfolio management under HNW account management
– Research	✓	✗	Insignificant revenue by itself, covered partially by equity trading Fisher index
– Margin lending	✗	✓	BEA does not include any identified interest income in gross output measure
– Repos	✗	✗	Mostly own financial activities
– Proprietary trading	✗	✗	No benefits to customers
– Others	✓	✗	Mostly interest income, no benefit to customers
• 6211 Commodity contract brokers and dealers	✓	✗	Insignificant revenue
• 6231 Security and commodity exchanges	✓	✗	Insignificant revenue
• 6282 Investment advice			
– Portfolio management	✓	✓	Physical measure for pension funds, mutual funds and HNW accounts; not covered by BEA explicitly
– Investment advice	✓	✗	Small and can not identify physical measure
• 6289 Service allied with exchanges of security and commodities	✓	✗	Small and cannot identify physical measure

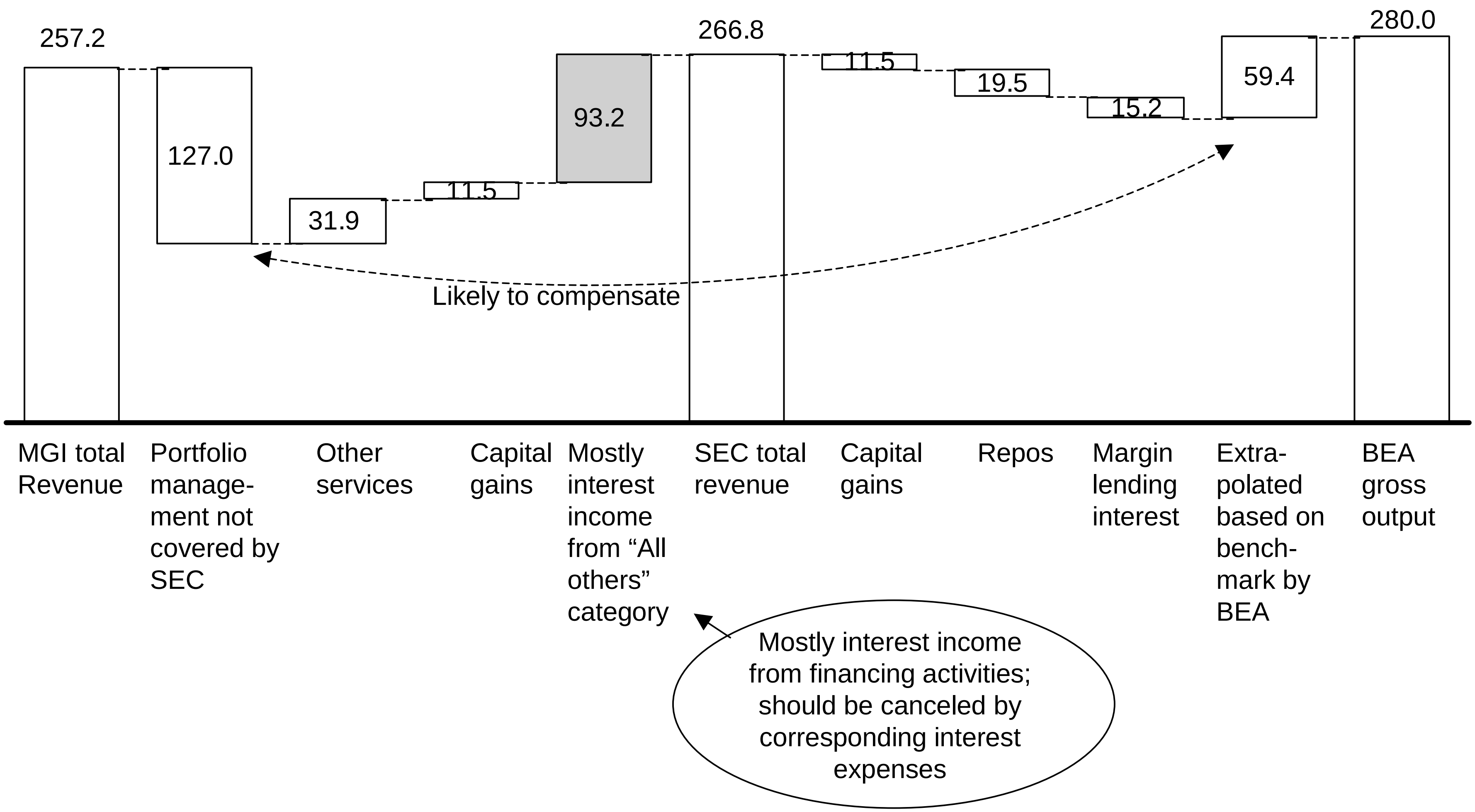
Source: BEA; MGI analysis

Exhibit A5

RECONCILIATION OF MGI AND BEA REVENUE WEIGHTS

Nominal revenue – 1999

$ Billions

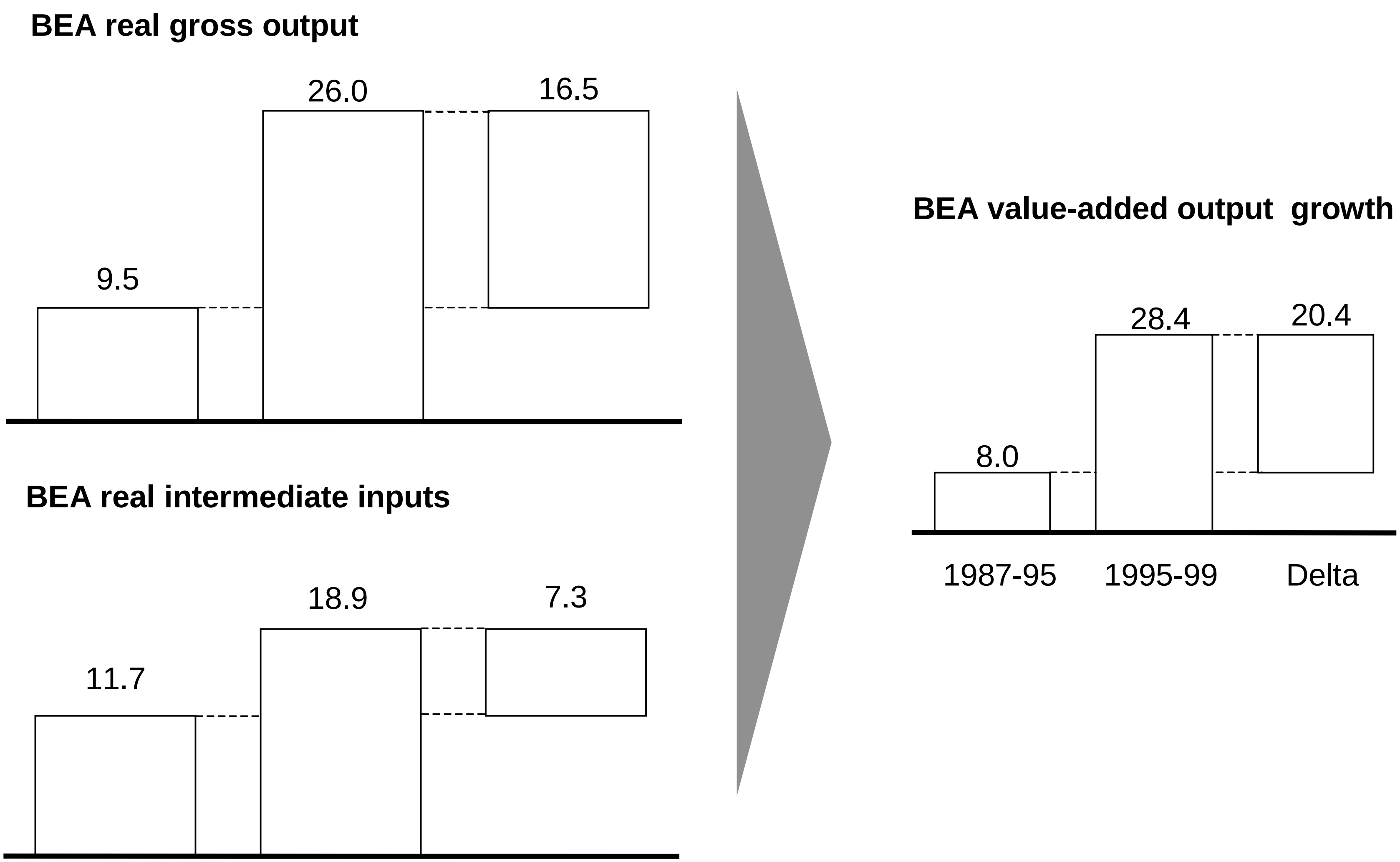


Source: BEA; SEC; SIA;MGI analysis

Exhibit A6

SLOWER ACCELERATION OF INTERMEDIATE INPUTS LEADS TO HIGHER PRODUCTIVITY ACCELERATION ON A VALUE-ADDED BASIS

CAGR, percent

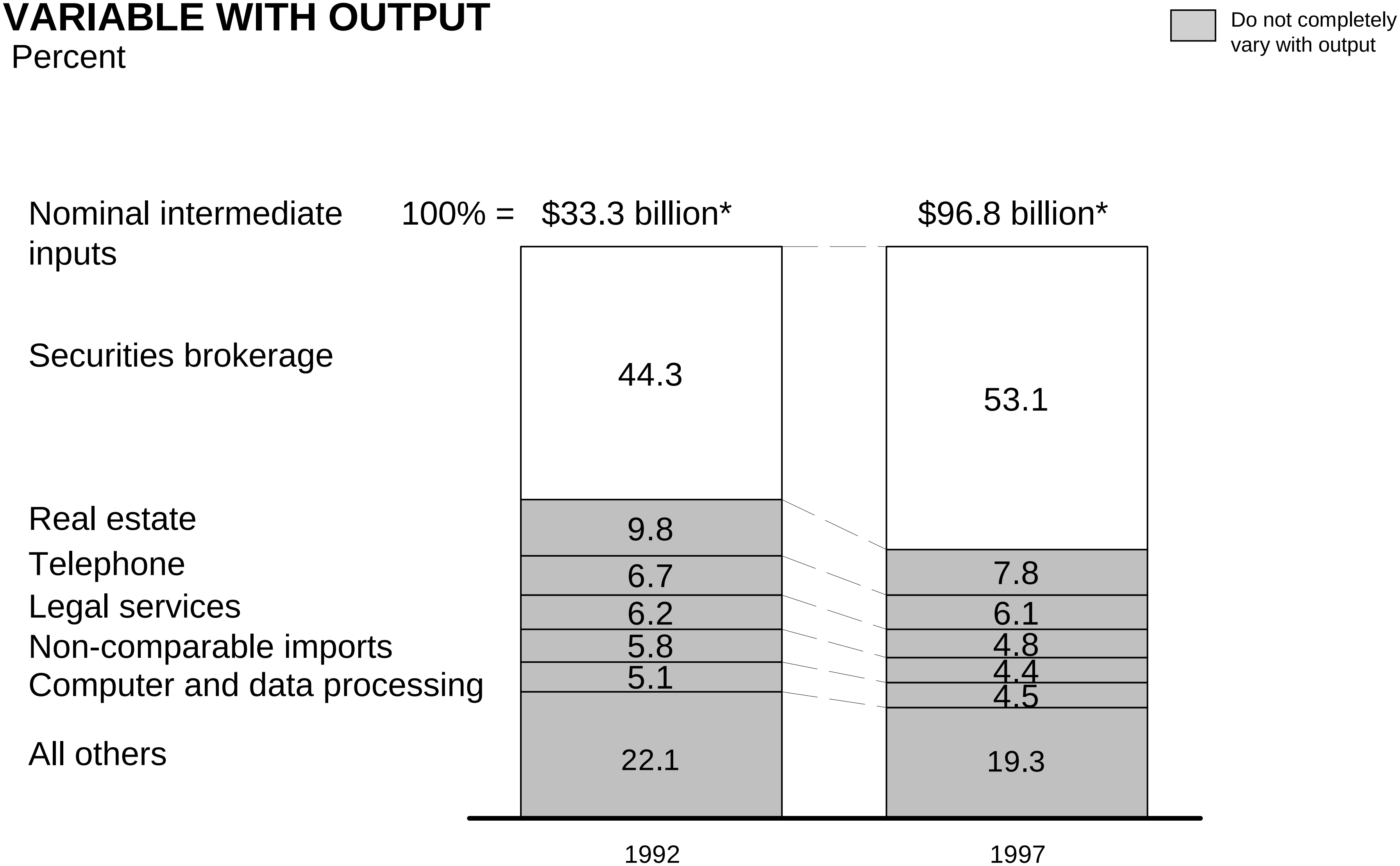


Source: BEA; MGI analysis

Exhibit A7

ABOUT HALF OF THE INTERMEDIATE INPUTS ARE NOT COMPLETELY VARIABLE WITH OUTPUT

Percent



* Total intermediate inputs from I-O table are close to but do not exactly match the data from GDP by industry due to BEA's adjustments

Source: BEA; MGI analysis

Retail banking

SUMMARY

Since 1982, retail banking labor productivity growth rates, although decreasing, have remained higher than those of the US private sector. In the early 1980s, significant changes in the banking industry increased competitive intensity, spurring banks to eliminate excess labor. Labor reductions and scale effects in payment transactions have helped maintain high labor productivity growth levels.

From 1995 to 1999, retail banking presented a paradox.[1] Despite a substantial acceleration in IT investments, labor productivity growth rates continued to decrease. The majority of post-1995 IT capital investments were associated with banks' focus on increasing revenues. The largest portion of these investments, customer information management and support, and sales automation, will facilitate banks' shift from product-centric to customer-centric organizations. Industry consolidation, new channels, and increased product range also contributed to the massive growth in IT capital in the late 1990s. Together, these strategies further raised systems' complexity and information transaction volume, increasing processing power requirements.

Retail banking IT capital investments should be analyzed in the context of a period in which banks enjoyed high levels of profitability. The increase in profits was primarily driven by the growth of noninterest income[2], due in part to the buoyancy of financial markets. Low levels of loan provision expenses and favorable interest rate margins also contributed to banking's strong performance. Large profits provided the resources for significant IT investments, which overcame banks' efforts to reduce costs.

The lower-than-expected productivity benefits from IT capital investments can be attributed to several factors: banks made some unnecessary investments in PCs (banks purchased PCs with more capability than needed by average users); some initiatives did not yield expected benefits (some CRM[3] projects, and selected mergers); banks faced unanticipated complexity costs (due to large and complex systems requiring additional processing power, and mergers), and some benefits to

---

1 Hereafter referred to as the "IT paradox."

2 Noninterest income, in addition to fiduciary fees and service charges on deposits, includes "other noninterest income," which is highly correlated with the financial markets (e.g., investment banking fees, servicing fees, venture capital revenue, and gains on assets sold).

3 CRM, or customer relationship management, is defined broadly as the management of customer interactions using customer data and information technology to increase the value and number of profitable customer relationships. CRM generally includes IT tools for the following areas: marketing, sales, and customer service and support.

customers may not have been fully measured. (MGI's measure may not fully capture quality increases in output.)

In the future, MGI believes retail banking labor productivity will continue to grow at high levels due to scale benefits from electronic payment transactions (e.g., debit cards) and management's increasing pressure to reduce costs as the economy continues to slow down. Cost reduction initiatives will result in a decline in banks' IT budgets, decreasing the rate of IT capital growth.

There are some additional opportunities for banks to accelerate labor productivity. They can deploy lean manufacturing processes and technologies, continue to migrate customers to more efficient channels like Voice Response Unit (VRU) call centers and ATMs, and shift customers from paper checks to on-line transactions and electronic payments. The latter change could yield significant productivity benefits. For example, a shift of 25 percent of paper checks to electronic checks over 5 years would yield an additional 1.8 percent annual productivity increase in the sector. This would contribute .03 percent to aggregate US productivity growth. However, slow consumer adoption of on-line transactions, along with regulatory and economic barriers, has limited progress on this front.

Retail banking

INTRODUCTION

The retail banking sector has experienced significant changes in the last 20 years. To understand the overall industry and to provide the context for our analysis, we will first provide an industry overview – including industry size, structure, regulatory changes, and competition – and then describe the importance of this sector in the context of the broader questions this MGI study seeks to answer.

Industry profile

Retail banking is an IT-intensive sector with higher labor productivity than the overall US economy. It represents 1.4 percent of total private sector employment, 2 percent of GDP and 4.5 percent of US private sector IT investment (Exhibit 1).

In 1999, a retail banking employee produced approximately $102,000 of value-added, while the average US employee produced $71,461. In 1996, IT nominal capital per employee was $15,835,[4] almost three times the US private sector average ($6,177).

Retail banking, as defined by MGI, includes the products and services that commercial banks, savings institutions, and credit unions provide to retail customers and small businesses. The main services provided to retail banking customers are payment transactions, deposits, consumer loans, and trust management. Services to medium and large businesses (e.g., wholesale banking, commercial loans) are not included in MGI's retail banking measure.

Retail banking employees of commercial banks, savings institutions, and credit unions represent 83 percent of total labor within the Standard Industrial Classification (SIC) definition of Depository Institutions. (Exhibit 2 maps MGI's definition of retail banking against relevant SIC 60 codes.)

¶ **Commercial banks.** The retail portion of commercial bank institutions employs 77 percent of the total labor in retail banking. In 2000, there were 8,315 Federal Deposit Insurance Corporation (FDIC) insured commercial banks in the US. The largest commercial banks in terms of assets were: Bank of America, N. A., The Chase Manhattan Bank, Citibank, N. A., First Union, N.A., and Morgan Guaranty Trust Company of New York.

---

[4] United States Government Bureau of Economic Analysis (BEA) data for SIC 60-Depository Institutions.

- **Savings institutions.** Savings institutions, also known as thrifts, represent 13 percent of retail banking labor and include savings banks and savings and loan associations (S&Ls). There were 1,590 savings institutions in 2000. The largest are Washington Mutual Fund and World Savings Bank.

- **Credit unions.** Ten percent of retail banking labor resides in credit unions,[5] which are cooperatives owned and controlled by the individuals who use their services. There are more than 11,000 credit unions in the US. The largest serve the employees of the Navy, the Pentagon, and the Boeing Company.

Retail banking has been subject to several waves of regulatory changes since the early 1980s. (See Exhibit 3 and Appendix 1 for further details.) Regulatory changes contributed to employment shifts in the 1980s. Interest rate deregulation increased competitive intensity and drove labor force reductions in retail banking. During the mid-1980s, the S&L crisis led to the elimination of half of all S&L institutions, which further decreased employment. By the mid-1990s this trend started to reverse, and by 1997 employment was increasing, as more labor was needed to support new retail banking channels and services (e.g., call centers, on-line banking).

Competition has decreased retail banking's market share of household assets and consumer loans. For deposits, retail banking competes with money market funds and the equity market. Bank deposits and CDs' share of household liquid assets have decreased from 48.2 percent in 1987 to 20.1 percent in 1999 (Exhibit 4). For consumer lending, retail banks compete with credit card companies, leasing companies and other nonbank financial institutions. Banks have been losing credit card market share to personal credit institutions, such as credit card companies (Exhibit 5).

Importance of retail banking industry to the overall question

Retail banking presents an IT paradox. Despite the large investments in information technology, retail banking labor productivity growth has slowed since 1995 (Exhibit 6). Retail banking's labor productivity growth rate decreased from 5.5 percent during 1987-95 to 4.1 percent during 1995-99. Simultaneously, the IT capital intensity growth rate increased from 11.4 percent in 1987-95 to 16.8 percent in 1995-99, nearly a 50 percent increase.

The retail banking case is relevant to MGI's overall study because it helps us develop explanations for why, in some cases, IT intensity growth increases

---

5 While credit unions are part of retail banking, they are not included in MGI measure due to lack of data.

without yielding labor productivity acceleration. The analysis that follows seeks to answer several questions:

- ¶ Did IT investments actually cause productivity improvements?
- ¶ If and where the investments did not enhance productivity, why were they made?
- ¶ Are some of the benefits not captured in the productivity measures?
- ¶ What factors influence the IT investment decisions and the role IT plays in improving labor productivity?
- ¶ How can IT help to increase future labor productivity?

Beyond the IT paradox, retail banking's historical performance sheds light on the impact of competition, regulatory changes, and technology on labor productivity. (See Appendix 2 for details.)

LABOR PRODUCTIVITY PERFORMANCE

MGI calculates labor productivity using a physical measure of output per hour worked. Since developing price deflators for retail banking activities would be extremely complex because of the lack of price transparency and data availability, MGI uses a physical output measure. To adjust for vertical integration and create a ratio comparable to value-added per hour, MGI has included in its measure of labor inputs the labor that retail banking outsourced to subcontractors such as First Data Corporation, Finserv, and call center service providers.

Retail banking's main activities (payment transactions, deposits, lending, and trust management) are decomposed into payment and information transactions, savings and time accounts, personal loans, real estate loans, and trust management. For each of these categories, physical measures are defined and then aggregated based on their revenue share. Labor input is defined in terms of hours and includes outsourced labor. (See Appendix 3 for methodological details and data sources.)

From 1987 to 1999, MGI's labor productivity growth measure is:

- ¶ Directionally similar to the labor productivity figures calculated using data from the Bureau of Economic Analysis (BEA). The data used was value-added per person employed in production (PEP).[6] Both MGI and BEA data show a deceleration in labor productivity after 1995.

¶ Consistently higher than BEA data by approximately 3 percentage points per year (Exhibit 7).

MGI's results from 1987 to 1999 differ from those calculated using BEA data because of the following:

¶ **Differences in scope.** MGI measures the retail banking sector, while the BEA measures depository institutions (Exhibit 2). The BEA's output figures are primarily based on the physical output measure for commercial banks developed by the Bureau of Labor Statistics (BLS). The BEA and BLS measures are not identical because of adjustments the BEA makes to include depository institutions.

¶ **Differences in methodology.** There are three methodological differences between MGI output series and BEA/BLS[7] real value-added series. (See Appendix 3 and the Measurement Appendix chapter for further details on measurement.)

- In the output measure, MGI includes transactions that BEA/BLS do not include, for instance, information transactions and debit card transactions.
- MGI uses revenue weights to aggregate output. BEA/BLS's measure aggregates output using labor weights. Labor and revenue weights tend to be very similar for the five groups of activities measured; therefore, this difference in methodology does not significantly impact the results.
- MGI uses the Fisher method to aggregate, while BEA/BLS use the Laspeyres method. The Fisher method is preferred by MGI, since it is the method BEA uses to aggregate output. Additionally, the Fisher method is considered "ideal" because it better approximates the effect of customer substitution while relative prices change.

From 1977 to 1987, MGI's labor productivity growth measure is significantly different from the BEA measure. Before 1987, the BEA did not use BLS physical output data to calculate depository institutions' real value-added figures. Instead, the BEA's real value-added estimates were derived primarily through the

6 To compare MGI's output per hour measure to BEA's data on value-added per PEP (as opposed to output per PEP), MGI's labor measure was adjusted for vertical integration to include outsourced labor, which is the main intermediate input in retail banking.

7 Since BEA's real value-added series for depository institutions are based on BLS's output series for commercial banks, hereafter BEA's real value-added series will be referred to as "BEA/BLS series."

extrapolation of labor input data. This calculation implicitly assumes no labor productivity growth since the change in the ratio of value-added to labor is always zero.[8]

EXPLAINING THE IT PARADOX

MGI has sought to understand what lies beneath the aggregate figures, which suggest that retail banking institutions have made large investments in IT capital that have not yielded proportional labor productivity benefits. Our approach to this undertaking was two-fold. First, we tapped into McKinsey's cadre of experts who serve retail banking institutions and have a perspective on the drivers of and returns on IT spending. Second, we spoke with the bankers themselves, both CIOs and other executives at major national and regional retail banks. Industry participants confirmed a general dearth of productivity enhancement (or financial benefit) associated with most investments.[9] The following analysis draws heavily upon our discussions with those who experienced the IT paradox firsthand.

Nature and goals of IT investments

In the late 1990s, retail banks focused on growth and customer cross-selling and retention strategies, and these goals led to large investments in IT capital. From 1995 to 1999, three IT equipment categories contributed to the acceleration in IT capital: PCs contributed 50 percent to the acceleration in IT capital, mainframes and servers contributed 18 percent, and prepackaged software contributed 14 percent (Exhibit 8).

Investment in these three equipment categories grew as a result of banks' investments in several IT initiatives: customer support, call management systems, analytic and sales tools, other CRM tools, customer data and systems integration, on-line banking, product proliferation, and Y2K (Exhibit 9). These initiatives increased both systems complexity and the volume of transactions, requiring additional processing power in back-office operations (mainframes). There are five main business strategies that banks pursued during the late 1990s that led to these IT initiatives:

Customer information management, support and sales automation. Banks' focus on integrating, capturing, and managing customer information, implementing customer support software, and developing analytic tools to increase

---

8 Labor productivity figures calculated using BEA data are not exactly zero because the BEA made other adjustments to its real value-added figures.

9 This does not mean there have been no productivity benefits from IT. Benefits were found in areas such as VRU systems in call centers and in check imaging. However, the impact of these benefits was far too small to reverse the paradox we are trying to explain.

cross-selling and up-selling created the largest driver of IT investment. This strategic focus will facilitate banks' shift from product-centric to customer-centric organizations. The implementation of tools like customer databases, CRM tools, customer support software, call management systems, analytics to predict customer behavior, and sales support required major systems integration efforts as well as large investments in PCs, servers, and prepackaged software.

Previously, retail banking institutions had been organized around product lines, each acting as a silo. Consequently, customer information did not flow easily across the different product lines. To develop a single, integrated customer view, retail banks began changing their processes and integrated their IT systems. The integration of IT systems increased IT capital and systems complexities.

In addition, front-end operations required additional functionality to use the customer information acquired. Therefore, banks installed PCs in their key channels (e.g., call centers, branches). Rapid changes in operating systems in the late 1990s caused banks to update their servers and PCs frequently, boosting IT capital.

Finally, to up-sell, cross-sell and retain customers, banks implemented customer information databases and tools (e.g., analytics, campaign management, sales automation, and contact management). These new CRM initiatives further increased system complexities and IT capital.

Mergers and acquisitions. Industry consolidation has been a trend in retail banking since the mid 1980s and banks had to make large investments to integrate their complex IT systems. In 1985 there were 14,147 commercial bank institutions and in 1999 there were only 8,581 (a 40 percent reduction). Although the rate of decrease in the number of banks has remained constant in the last 15 years, the size of bank mergers has increased[10] due to interstate deregulation.[11] As the size of mergers grew, banks had to invest larger amounts to integrate their IT systems.

Multi-channel approach. The emergence of the Internet as a new channel for on-line services drove investments in IT capital in the late 1990s.

- ¶ The Internet enabled the emergence of a new type of bank, the "virtual bank," which operates exclusively on-line. These new entrants had to make large investments in IT to create the infrastructure to compete with traditional banks.

---

10 The average merger size, measured in total assets, was $700 million from 1994-96 and grew to $1.4 billion from 1997-1999.

11 See "Appendix 1: Regulatory waves in retail banking" for details on the Riegle-Neal Interstate Banking and Branching Efficiency Act (1994).

- ¶ Traditional “brick and mortar” banks invested heavily in on-line banking services to avoid losing market share to new on-line banking players. Online banking services also provided banks with potential cost reduction opportunities (e.g., decreasing the number and size of banks branches, reducing call center inquires), and new revenue streams (e.g., payment transaction revenues).

Product proliferation. In an effort to satisfy customers’ needs, banks increased product customization and offered various product bundling and pricing options. This level of customization heightened programming, maintenance, and testing costs. These bundles and pricing combinations also increased system complexity and the need for additional processing power. Finally, banks began offering insurance and securities products, further increasing complexity.[12]

Disaster avoidance (Y2K). From 1996 to 2000 banks updated their systems to avoid any potential disruptions associated with the new millennium.[13]

Other IT initiatives. In the late 1990s, banks also invested in several smaller IT initiatives, which increased their IT capital stock. Examples included imaging technologies, VRU systems, wireless banking, software upgrades, new PCs in support areas (such as HR, accounting, and finance), check imaging, and Euro compliance.

Although the returns from most of the major IT investments have been disappointing, as we will see in the next section “Explaining the IT paradox,” IT has contributed to an increase in labor productivity in at least two areas:

- ¶ Imaging technologies have allowed banks to decrease labor and storage costs in the check processing area. From 1928 until the mid-1990s, banks used microfilm systems to store and retrieve checks. Check image technology has replaced microfilm systems, reducing storage costs up to 40 percent (including labor) and check retrieval time by 75 percent in selected banks.[14] There is potential for further cost reductions if banks implement centralized, shared operations for archival and retrieval of checks[15].

- ¶ VRUs have allowed banks to decrease labor significantly in call centers. In 1999, 55 percent of call inquiries were served by VRUs. MGI

---

[12] In addition, banks began offering insurance and securities products. These products are not part of our retail banking scope, as defined by MGI. Therefore, IT investments in these products are not included in our analysis.

[13] Y2K capital investments comprise 5 percent of total IT investment across 1996-99. Besides capital investments, banks incurred expenses as a result of Y2K that roughly equaled Y2K investments in magnitude.

[14] Source: Tower Group.

[15] There are other areas where imaging technologies have been implemented with less success, such as proof of deposits.

estimates that to answer these calls without VRUs, banks would have had to increase the number of call center agents by 86 percent. This would have decreased labor productivity growth around 1 percent per year since the early 1990s and changed the post-1995 deceleration in productivity from 1.4 percent to 1.6 percent.

Causality analysis

To simplify comparisons across "paradox" cases, MGI developed a framework for explaining IT investments that did not drive productivity enhancement. As with the framework for explaining productivity growth jumps, this paradox framework focuses on operational, industry level, and external factors. The analysis that follows begins in the trenches (at the operational level) and moves up to industry-level and external factors that helped drive the IT paradox operationally (Exhibit 10).

Firm- level factors

The IT paradox was primarily the result of the following "operational," or firm-level, factors:

Some excessive or unnecessary investment in PCs. According to the BEA, depository institutions spent an average of $5,253 per employee (equivalent to two new computers) on PCs from 1995 to 1999 while the average US private sector firm spent $440 per employee during the same time period (Exhibit 11). In real terms,[16] the depository institutions' investment in PCs grew more than three-fold from 1995 to 1999.

Drivers of demand for PCs include customer information management, support and sales automation tools (see above), and the increased processing and memory requirements of more powerful software. Although some PC purchases were necessary, MGI's interviewees indicated that there is significant excess PC capacity (processing power) in banking (Exhibit 12). Two dynamics within banks contributed to the over-investment in PCs (Exhibit 13).

¶ Banks, for maintenance and deployment purposes, set standards for PC purchases. High-end users requiring very powerful PCs typically defined these standards. Therefore, when banks purchased standard PCs, average users obtained more functionality than needed. This dynamic contributed directly to the surge in computing power possessed by banks, as measured in the real PC capital stock. However, it also likely reduced

---

[16] The real value of computers accounts for increases in computers' quality (e.g., processing power).

maintenance expenses for banks by increasing the ability of IT support staff to specialize and efficiently address common problems.

¶ There were few strict controls for PC purchases. Purchasing decisions were typically made at the division/department level, and the costs were capitalized, so the impact on banks' immediate profits was minimal. Furthermore, rapid PC price declines led to the perception that PCs were inexpensive.

Some software and hardware investments that did not yield expected benefits. Typically, top-line (or revenue-oriented) types of projects like CRM and sales automation, and product proliferation are characterized by longer lead times to bear fruit compared to cost reduction projects. Aside from the intrinsic challenge that these types of projects present, retail banks had several additional difficulties in the implementation of these projects. Lack of clear focus and objectives, complexities within the organization, project cancellations (in the case of mergers), and unanticipated complexity costs have all hindered the success of some of the hardware and software investments.

¶ **CRM/customer information management and analysis**. The majority of CRM projects have failed to achieve the returns expected (Exhibit 14). Banks have focused their efforts on building a large infrastructure to capture data, implementing analytic tools to predict customer behavior and automating sales and marketing functions. To date, few banks have developed the skills and processes to effectively use the information and tools in place.

Most retail banks invested in CRM projects without performing a comprehensive analysis of expected returns. Moreover, a lack of clarity around CRM objectives exacerbated the limited scrutiny of CRM investments by increasing implementation costs, causing many CRM initiatives to be financial failures to date.

Furthermore retail banks, as multi-channel and multi-product organizations, face large complexities when implementing CRM projects. The challenges are not only technological. While varied product areas may have integrated data, they are still accustomed to working as silos and pursuing their own agendas. Consequently, it has been difficult to develop a consistent customer approach.

Finally, sales automation tools, customer support, call management, sales support and other CRM tools resulted in large integration efforts. The integration of these new software applications and databases to the old banks' legacy systems required new interfaces and additional software modifications, which raised systems complexity and increased IT development costs.

¶ **Mergers.** Mergers caused some existing IT projects to be re-evaluated or terminated. Those projects-in-progress that were not completed consumed significant IT capital with no possible return.

Mergers required significant systems integration and capacity expansion. Banks involved in continuous or large mergers developed complex IT systems, which raised the costs of current operations and future implementations.

¶ **Product proliferation.** Product proliferation caused software performance to degrade, necessitating additional processing power to offset performance reductions (Exhibit 15). Complex product bundles also drove IT maintenance and testing budgets.

Unmeasured convenience to consumers. Some consumer benefits such as convenience and quality increase in information transactions may not be fully captured in MGI's or BEA's labor productivity results. However, sensitivity analysis indicates that even if benefits from convenience and quality increases in information transactions are valued at high levels, they are insufficient to eliminate the IT paradox.

Payment transactions like checks and transfers made through on-line banking may be considered more convenient than the traditional process of sending a check through the mail. Since MGI's labor productivity measure assigns equal value to all checks regardless of how they were originated, the value of the convenience may not be fully captured.

Similarly, customers have access to account information through on-line banking and call centers. The completeness and quality of the information has increased in the last 5 years. While MGI measures the number of information transactions (e.g., requests for information on recent transactions, balance inquiries), the value assigned to these transactions has remained constant over time. Therefore, the improvements in completeness and accessibility of information may not be fully captured.

Sensitivity analysis has demonstrated that the convenience value from on-line banking is not large enough to shift the 1995 delta from negative to positive. On-line banking penetration has been low, so the number of consumers benefiting from this channel and its impact on labor productivity is still small (Exhibit 16).

Similar to on-line transactions, information transactions are not a significant portion of the total number of transactions, and therefore the impact of increasing the value of information transactions over time would be small. Assuming customers' value of the quality of information transactions increased 20 percent per year after 1995, this would not be enough to shift the 1995 delta from negative to positive (Exhibit 17). An increase in the value of the quality of information by 20 percent is equivalent to customers willing to pay 20 percent more for information services, which seems unrealistic.

In the aggregate, even though customers now have access to multiple retail banking channels and the quality of information transactions has increased, customer satisfaction has decreased (Exhibit 18). Falling customer satisfaction calls into question the impact of these benefits on consumers. Furthermore, consumer research shows that retail banking customers are less interested in additional channels and prefer better customer service and a higher level of reliability.

Industry dynamics

The retail banking sector presents an interesting dynamic in which banks simultaneously compete intensely in some lines of business like credit cards, while they are relatively protected in others like checking accounts. While the retail banking industry faces competitive pressures from mutual funds and personal credit institutions (see section "Retail banking sector overview" above for details), it is in no danger of extinction. Even as the average balance on checking accounts has decreased, the number of checking accounts has increased. In 1998, 86.8 percent of American families held at least one checking account.[17] The inconvenience associated with changing accounts makes them relatively "sticky" products and a steady source of income for banks.

These industry dynamics contributed to the IT paradox by simultaneously driving banks to invest in business strategies that would competitively differentiate them and ensuring that they would have the resources to make large investments. Two additional pieces of evidence help illustrate this dynamic:

¶ The industry became more concentrated as a result of merger activity. From 1995 to 1999, the top five bank holding companies' share of total US deposits increased from 14.8 percent to 26 percent. Regionally, the level of concentration among bank holding companies also increased (Exhibit 19). This increase enhanced banks' ability to withstand competitive threats in other areas of their business by increasing fees for basic services. Banks' income from service charges on deposits increased from $16 billion to $21.5 billion between 1995 and 1999.

[17] Source: Survey of Consumer Finances; Federal Reserve.

- The industry has been highly profitable since 1993, indicating that in spite of competitive pressures, banks have been able to avoid competing away some returns (Exhibit 20). Retail banking's large profits also highlight the low impact of any excess IT spending on overall performance.

External factors

The two primary exogenous factors that contributed to the IT paradox were capital markets and product market regulation. The buoyancy of capital markets increased banks' profits and provided the resources for large IT investments. Product market regulation had two effects. First, interstate banking deregulation facilitated mergers and increased IT integration costs. Second, banking regulation, by encouraging the use of paper checks, deterred the growth of highly productive electronic transactions. The difficulty in measuring some consumer benefits has also contributed, but to a lesser extent, to the IT paradox.

Capital markets/demand effects. Capital markets helped banks enjoy the large profits that made available the resources necessary for large IT expenditures and to overcome cost reduction efforts. Profits increased primarily because of the large growth in noninterest income, which is correlated to the strong performance in financial markets (Exhibits 21 and 22). The low interest rate levels during the 1990s also helped to boost lending activity. Additionally, strong economic growth in the US helped maintain the low levels of loan provision expenses.

Product market regulation. Two major regulatory factors have contributed to the IT paradox:

- The Riegle-Neal Interstate Banking and Branching Efficiency Act (1994) allowed bank holding companies to acquire banks in any state beginning in 1997. This led to a wave of large interstate banking mergers, which increased industry concentration and IT spending (Exhibit 23).

- On-line banking could generate significant productivity benefits if used to conduct electronic funds transfers (EFTs) rather than distribute paper checks. According to the Electronic Fund Transfer Act of 1978 (EFTA) and Regulation E,[19] most EFTs generally have to be executed one business day after the transfer. The Expedited Funds Availability Act of

[18] Other transaction accounts (e.g., money market accounts, and brokerage accounts) are not included in this number.

[19] Electronic Fund Transfer Act (1978) and Regulation E establish the rights, liabilities, and responsibilities of parties involved in EFTs and protect consumers using EFT systems.

1987 (EFAA) and Regulation CC[20] established that funds for checks should be available within one to five business days after the day of deposit. This time difference makes checks more attractive as it helps banks earn more revenues from the interest float[21] and encourages banks to maintain the current paper checking system, at least until banks develop a pricing mechanism to increase the value they capture from electronic transfers. Aside from the economic and regulatory barriers discussed, checks have proven extremely entrenched in the US as customers still prefer checks to other more efficient paying mechanisms (e.g., credit card and debit card).

Unmeasured consumer benefits. The reason some customer benefits may not be fully captured is that it is extremely difficult to quantify the value of either incremental convenience improvements, or increases in the quality of banking services.

OUTLOOK, 2001-05

Whether banks' past IT investments will yield substantial productivity benefits in the future remains unclear. Banking executives believe benefits from past IT investments (e.g., CRM) are forthcoming as it takes time for banks to adapt to the new processes and technology in place. MGI remains skeptical that IT investments will significantly enhance productivity in the future since most banks have not proven their ability to capitalize on these new technologies (Exhibit 24). However, banks can begin to capitalize on IT in several ways: more on-line banking and electronic transactions, lean manufacturing processes and technologies, and migrating customers to more efficient channels (VRU call centers, ATM).

Even though on-line banking and electronic transactions have the potential to improve labor productivity growth by replacing paper checks, economic and regulatory barriers and customer behavior have inhibited this process in the past. It is unlikely that these barriers will be eliminated in the near future.

¶ Consumers generate 61 percent of the checks in the US; a fourth of these checks are payments in stores, and the remaining 35 percent are bill payments to consumers and businesses. MGI estimates that one-third of

---

[20] Expedited Funds Availability Act (1987) and Regulation CC establish time limits for fund availability for checks. Certain "low-risk" checks, such as cashier's checks, government checks, teller's checks, and checks drawn or guaranteed by credit-worthy institutions, must be made available for withdrawal the next business day following the day of deposit. Local checks (checks in the same processing region) must be available for withdrawal within two business days, and nonlocal checks within five business days after the deposit day.

[21] Interest float is the time between presentation of a check and the actual collection of the funds.

the total checks originated by consumers could be replaced by electronic transactions once on-line penetration increases. The impact of this change would be an increase in labor productivity of 10 percent in the next 5 years, or 1.8 percent per year, everything else remaining constant (Exhibits 25 and 26).

¶ The economics of the check payment system, combined with current laws and regulations, will remain an obstacle in the elimination of paper checks in the on-line banking channel. Banks receive $60 billion annually in income from checking accounts through the fees, interest float on checks, and the checking balances, which are a source of low-cost funds.[22] This revenue would decrease if checks were to be replaced by electronic transactions, since this type of transfer greatly reduces the float. (See section “External factors: product market regulation” above for details). Additionally, electronic transfers generally guarantee funds, eliminating potential bank income from insufficient funds charges.

Future labor productivity growth in banking will be affected by any slowdown in US economic growth. As part of cost reduction initiatives, banks’ IT investments will fall, potentially decreasing the rate of IT capital growth and reversing the IT paradox. Management’s increasing pressure to reduce inputs as the economy slows down and scale benefits in transaction processing will maintain retail banking labor productivity growth at high levels.

22 Source: Greensheet

APPENDIX 1: REGULATORY WAVES IN RETAIL BANKING

Interest rate deregulation. Prior to 1980, the interest rate on deposits was regulated and competition in banking was limited. In 1982, the DIDMCA[23] established "NOW accounts," and began the phase-out of interest rate ceilings on deposits. These changes resulted in increased competitive intensity and rapid labor productivity growth. (See Appendix 2, "Explaining the 1982-87 labor productivity jump," for details).

Product deregulation. The product restrictions established by the Glass-Steagall Act[24] of 1933 have essentially disappeared. In the late 1980s and early 1990s banks gradually started to provide equity trading services. In the early 1990s they began selling insurance brokerage services. In 1999, the Gramm-Leach Bliley Act allowed banks to acquire insurance underwriters through bank holding companies.

Elimination of geographic barriers. Before 1994, banks were protected by geographic barriers. These barriers were eliminated by the Riegle-Neal Interstate Banking and Branching Efficiency Act (1994), which permitted bank holding companies to acquire banks in any state beginning in 1997. Riegle-Neal facilitated a wave of interstate mergers that increased industry concentration. (See "Explaining the IT paradox" for details.)

Changes in supervision. After the S&L crisis, the FDIC assumed supervision of savings institutions. In 1991, the FDIC also established a risk-based supervision method focused on undercapitalized banks. These changes in supervision, coupled with the elimination of troubled banks[25] and savings institutions after the S&L crisis in 1980s, resulted in a "new start" for the retail banking sector. By 1993 balance sheets had been largely cleaned of bad debt and loan provisions had significantly decreased.

---

23 Depository Institutions Deregulation and Monetary Control Act (1980).

24 Glass Steagall separated commercial banking from investment banking, establishing them as separate lines of commerce. It also established the Federal Deposit Insurance Corporation (FDIC).

25 Banks were also affected, but to a lesser extent, by the real estate crisis and regional recessions (e.g., oil bust in Texas, defense spending cuts in California, etc.) that led to the S&L debacle.

APPENDIX 2: EXPLAINING THE JUMP IN 1982-87 LABOR PRODUCTIVITY GROWTH

MGI has determined that the period of most rapid labor productivity growth in retail banking was 1982 to 1987. The objectives of this section are to explain the drivers of the increase in the labor productivity growth rate and the factors affecting the duration of the labor productivity jump.

Causality analysis

The increase in competitive intensity from the surge of money market funds and deregulation of the interest rate ceiling on deposits was the main driver of the 1982 labor productivity jump in banking.[26] Before 1980, retail banks enjoyed monopoly power on checking accounts and were under only limited pressure to maintain efficient operations. In 1980, the Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMCA) eliminated interest rate ceilings on deposits, allowing banks to compete with money market funds. As competition for deposits intensified, pressures to reduce costs increased. In the early 1980s banks began laying-off excess labor and consolidating back-office operations, boosting productivity. Although the number of branches increased, the number of employees decreased as branches became smaller. Simultaneously, the growth of electronic transactions (e.g., ATM and credit card) generated productivity benefits because of their small variable labor requirements. Finally, an increase in the number of real estate loans, resulting from declining interest rates after 1982, allowed banks to leverage fixed labor in loan processing and servicing activities (Exhibit A1).

Firm-level factors

At the firm level, the main factors contributing to the 1982 labor productivity jump were banks' improvements in the organization of functions and tasks (OFT) and scale benefits resulting from electronic transactions growth.

OFT/Process redesign. OFT improvements contributed 5.6 percent to the 7.2 percent labor productivity jump. From 1982 to 1987, banks spurred excess labor and consolidated back-office operations. Consequently, labor hours declined by 0.7 percent per year despite the 5.4 percent increase in output (Exhibit A2).

---

[26] Some studies have found large inefficiencies in the banking industry (up to 20 percent of more than total banking industry costs) during the early 1990s. (See Berger and Mester, 1997.) One of the explanations for high inefficiency is that banks had extra capacity generated during the 1980s when banks expanded branches to better compete after deregulation. Our measure of labor productivity shows that although the number of branches increased, total labor decreased as banks consolidated back-office operations. It also shows that competition eliminated less efficient banks and S&Ls. Meanwhile, output increased significantly, boosting labor productivity.

Limited competition in retail banking before the late 1970s resulted in significant excess labor capacity in the industry. Labor hours grew 3.3 percent per year during 1977-82, while output grew only at 2.2 percent. In the late 1970s, competition from money market funds increased pressure on banks to reduce costs and eliminate excess labor.

IT investment contributed to labor reductions through back-office consolidation. During 1977-82 banks invested heavily in IT and more specifically in mainframes (Exhibit A3). These computers enabled process redesign and centralization of back-office operations, reducing labor in branches.

Labor economies of scale. Scale benefits in electronic transactions allowed banks to leverage fixed labor and contributed approximately 1.6 percent of the 7.2 percent jump in labor productivity in 1982.

Electronic payment transactions (ATMs and credit cards) grew almost 5 percentage points faster from 1982 to 1987 than from 1977 to 1982 (Exhibit A4). Since these transactions required limited variable labor, their growth raised labor productivity, and contributed approximately one-third of the 1.6 percent contribution from economies of scale.

Furthermore, the number of real estate loans declined 16 percent per year from 1977 to 1982 and rose 25 percent per year from 1982 to 1987 (Exhibit A5). This 40 percent acceleration in output allowed banks to leverage some fixed labor in loan processing and servicing, and contributed to the remaining two-thirds of the 1.6 percent contribution from scale.

Industry dynamics

The early 1980s was a period of significant regulatory change for the banking sector. Competitive intensity increased as banks lost their virtual monopoly power on checking accounts, interest rate ceilings on deposits were eliminated, and geographic barriers began to erode.

Prior to the late 1970s competition in banking was limited. There were regulatory barriers for branch banking in several states, commercial banks had monopoly power on checks, and interest on deposits was regulated.

In 1980 thirteen states prohibited branch banking of any type, and sixteen allowed only limited branch banking, protecting banks from competition. Commercial banks had maintained a virtual monopoly on checking accounts since the passage of the Glass Steagall Act. Competition in checking accounts started in 1972 when the Consumer's Savings Bank of Worcester, MA, introduced Negotiable Order of Withdrawal (NOW) accounts, which were similar to checking accounts but paid interest. Commercial banks prevented the spread of NOW accounts outside of New England until 1980.

Regulation Q[27] of the Federal Reserve Act eliminated interest on demand deposits, and established interest rate ceilings on time and savings accounts. In 1973 interest rate ceilings for large CDs were eliminated, but Regulation Q continued to determine interest rate ceilings for small time and savings accounts until 1980. By the late 1970s, technological innovations and new saving devices created substitutes for bank deposits. The strongest threat came from Money Market Funds (MMF), offering interest rates above those permitted by Regulation Q.

In the late 1970s, market interest rates were above Regulation Q for several years, facilitating the growth of MMFs. Initially, MMFs targeted large clients, but by 1978 MMFs began pooling together money from small investors, allowing them to earn high interest rates on small deposits. From 1978 to 1982 assets under MMFs grew from $10 billion to $206 billion.

Banks were unable to compete until, in 1980, Congress passed the DIDMCA, which authorized retail banks to offer NOW accounts, and began the phase out of Regulation Q. Competition increased not only with money market funds but also among commercial banks and thrifts. These two institutions competed aggressively on loans and deposits, decreasing interest margins. Thrifts were less prepared to compete because of deteriorating balance sheets. The increase in cost of funds, caused by the elimination of interest ceilings on deposits among other factors, worsened thrifts' financial situation.

External factors

Three external factors contributed to the 1982 labor productivity jump: product market regulation, technological innovations, and demand effects. From these factors, product market regulation (in this case deregulation) was the main driver of the labor productivity jump since it led to a significant decrease in excess labor by increasing competitive intensity. Technological innovations also contributed to the labor productivity jump and have helped maintain high labor productivity growth levels by creating significant economies of scale in electronic payment transactions. Finally, banking also benefited from decreasing interest rates, which boosted refinancing and the number of new mortgage loans.

Product market regulation. Changes in product-market regulation in banking increased competitive intensity. These changes also are considered to have contributed to the S&L crisis. Commenting on the latter, which indicates that deregulation led to an increase in labor productivity growth, is out of the scope of this analysis.

---

[27] This regulation authorized the Federal Reserve to establish interest ceilings on deposits, with the purpose of limiting competition following the failure of about one-third of US banks, after the Great Depression of the 1930s.

¶ The DIDMCA (1980) began the phaseout of interest rate ceilings on deposits in 1980. This act also increased powers of thrifts (saving mutual banks and S&Ls). It was meant to increase retail banks' ability to compete against MMFs and began the phaseout of Regulation Q. The DIDMCA also allowed banks and thrifts to provide NOW accounts, and increased the account limit on deposit insurance from $40,000 to $100,000.

The DIDMCA provided more latitude to thrifts institutions, which were losing money because of the rapid increases in interests rate coupled with their asset/liability mismatch.[28] Under the belief that the thrift crisis was temporary, interest rates would go down, and thrifts will be able to restructure their portfolios, the DIDMCA reduced net worth requirements for S&Ls and expanded their investment powers.

¶ The Garn-St Germain Act (1982) allowed retail banks to offer money market accounts, further decreased capital requirements for thrifts, and liberalized their investment activity. Because the act allowed retail banks to offer money market accounts, banks could successfully compete with money market funds, and deposits increased.

The act also expanded the types of loans and investments thrifts could make, raising the limit on commercial loans to 5 percent and on consumer loans to 30 percent of total assets. It also loosened net worth requirements.[29] Finally, Garn-St Germain helped to erode interstate banking limitations by allowing mergers across states in emergency cases.

Technology/innovation. The growth of electronic transactions was the result of past technological innovations that achieved significant penetration during the 1980s. ATM penetration increased during the 1980s, with two effects on labor productivity. First it allowed banks to substitute capital for labor. Second, rapid increases in transaction volume allowed leverage of fixed labor.

Credit card transactions achieved critical mass in the 1980s. As with ATM transactions, growth in credit card transaction volume did not require proportional increases in labor.

---

28 Interest income comprised primarily by fixed interest from long-term mortgage loans. Interest expense was mainly variable short-term interest.

29 Garn-St Germain eliminated the ratio between what an S&L could lend to a developer and the appraised value of the project for which the loan was made.

Demand factors. During the 1970s the US experienced a period of high inflation, which raised interest rates and decreased real estate lending activity. In the 1980s interest rates declined, boosting real estate consumer loans in commercial banks.

Conclusion

The retail banking labor productivity jump in 1982 was the result of major industry changes, which increased competitive intensity. Deregulation, by eliminating interest rates on deposits and foster competition, helped to reduce large inefficiencies built during banks' period of monopolistic power, and the effects of deregulation have continued until now.[30]

Technological innovations in electronic transactions (e.g., credit card, ATMs) have increased banks' economies of scale and helped sustain high labor productivity growth levels. Credit card and ATM transactions had double-digit growth rates during the 1980s and most of the 1990s, increasing output with minimal additional labor.

---

[30] Although banks' monopoly power on checking accounts was eliminated and competitive intensity increased, banks still have remained the main providers of checking accounts and have been able to extract revenues from consumers through deposit fees. (See section "Explaining the IT Paradox: industry dynamics" above for details).

APPENDIX 3: LABOR PRODUCTIVITY MEASURE

This appendix describes the data sources and methodology used to calculate the labor productivity series for Retail Banking.

Output measure

MGI's retail banking output measure is a Fisher quantity index of the number of payment and information transactions, savings and time accounts, personal loans, personal real estate loans, and trust accounts (Exhibit A6).

Transactions. Transactions were classified into payment and information transactions. Payment transactions include checks, credit card, point of sale (POS) or debit card, and ATM transactions. Information transactions were measured as the total number of call information inquiries, on-line information inquiries, and ATM information transactions. MGI has used several sources to collect this information (Table A1).

Table A1

Payment transactions	**Data source**
Checks	• International Bank for Settlements • BLS time series
Credit card transactions	• Card Industry Directory, Faulker and Gray • Nilson reports
POS transactions	• Nilson reports
ATM transactions	• Card Industry Directory, Faulker and Gray
Information transactions	**Data source**
On-line inquiries	• Banking Online Report • McKinsey research
Call inquiries	• Retail Banking Industry Report, American Banker Association
ATM information inquiries	• Card Industry Directory, Faulker and Gray • McKinsey research

Savings and time accounts. Savings and time accounts included statements, passbooks, money market accounts, IRAs, CDs, and club accounts. Post-1980 data for the number of accounts was obtained from the American Banker Association (ABA). Before 1980, the data was calculated by extrapolating the Bureau of Labor Statistics (BLS) index series for the number of time and savings accounts.

Personal loans. Personal loans were measured as the number of revolving (e.g., credit cards) and nonrevolving loans (e.g., auto loans). To estimate the average number of revolving loans, MGI divided the total balance of revolving loans originated by retail banks (including securitization) by the average value of a revolving loan, which was obtained from the Federal Reserve Survey of Consumer Finances. The source for the number of nonrevolving loans was the BLS.

Personal real estate loans. Personal real estate loans were measured by dividing the home equity loan balance in commercial banks' financial statements by the average value of home mortgages. The source of the average value of a personal home mortgage was the Federal Deposit Insurance Corporation (FDIC) and the American Mortgage Association.

Trust accounts. Trusts were measured by the number of trust accounts managed by commercial banks and savings and loan institutions. The source of this data was the FDIC.

Total labor measure

Total labor in retail banking was measured by the number of full-time equivalent (FTE) employees in commercial banks and savings institutions' payroll, plus outsourced FTEs, less the number of workers that performed non-retail activities.

Number/FTEs. The numbers of FTEs in commercial banks and savings institutions was obtained from the BLS.

Outsourced labor. Outsourced labor was found primarily in call centers, transaction processing, and IT services. Outsourced labor was estimated by adding FTEs from the largest transaction processing providers (Finserv and FDC, among others). The number of FTEs in call centers was estimated using ABA reports and annual 10-K reports for the largest banks.

Workers with nonretail activities. The number of workers that perform nonretail activities (e.g., commercial loans or commercial real estate loans) was derived from the Federal Reserve Function Cost Analysis report.

Calculation of physical output categories

MGI has aggregated each of the five physical output categories using revenue share. To estimate the revenue share for transactions, deposits, loans and trusts MGI used the "user opportunity cost" approach.

Revenue from customer deposits. Banks could borrow money from other banks or from depositors. The interbank lending rate is usually higher than the interest rate banks pay to depositors. The difference between these two rates is the "revenue" a bank receives for each dollar a customer deposits.

- The revenue from transactions is calculated as the difference between the interest a bank would pay for short-term funds and the interest banks pay on checking accounts. Additionally, transaction charges are also part of the transaction revenues. Transaction's share of total retail banking revenue is 61 percent.
- The revenue from savings and time accounts is calculated in a similar way. Naturally the revenue from time and savings accounts (on a per dollar basis) is small for banks since the interest rate banks pay on those accounts is higher than the interest they pay on checking accounts. Time and saving's account's share of total retail banking revenue is 8 percent.

Revenue from retail loans. Banks' revenues from retail loans are defined as the difference between the interest rate banks charge when they lend the money to retail customers and the interest rate banks could charge if they lend the money to another bank (assuming similar maturity and risk). The revenue share from personal loans is 12 percent and the revenue share from real estate loans is 7 percent.

Revenue from trusts. Banks' revenues from trusts were obtained from FDIC data. The revenue share from trusts is 12 percent.

CONFIDENTIAL

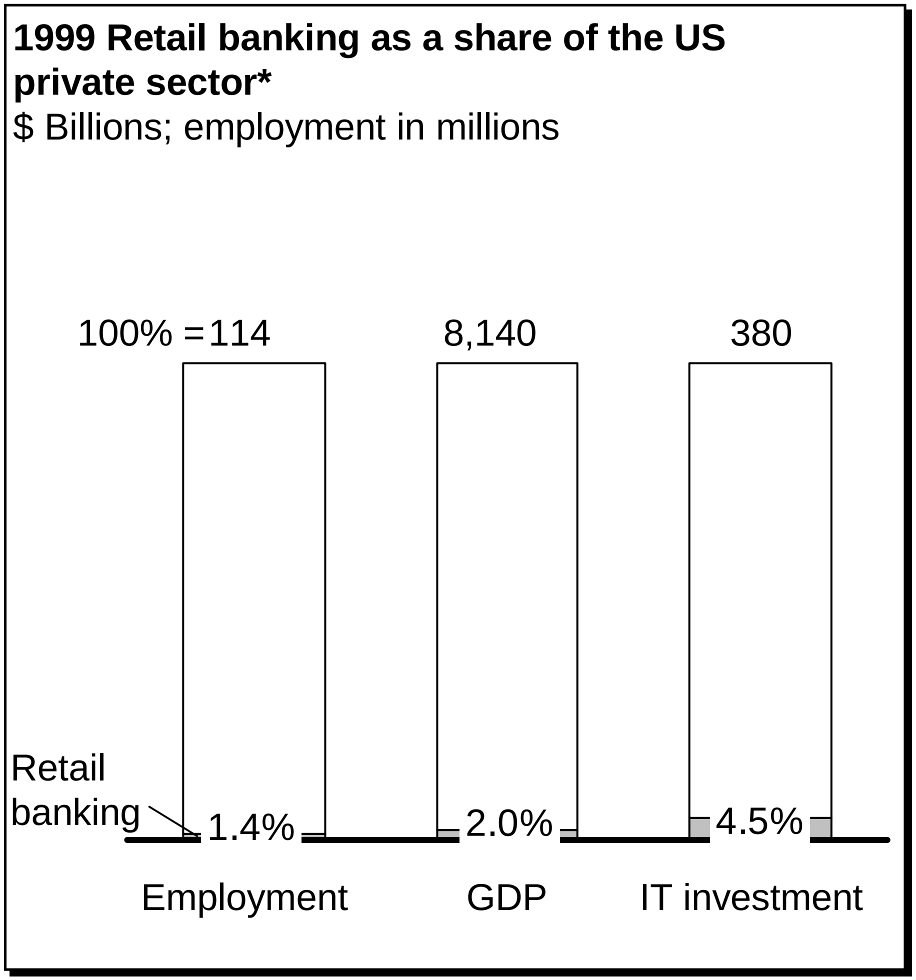
Retail Banking Exhibits

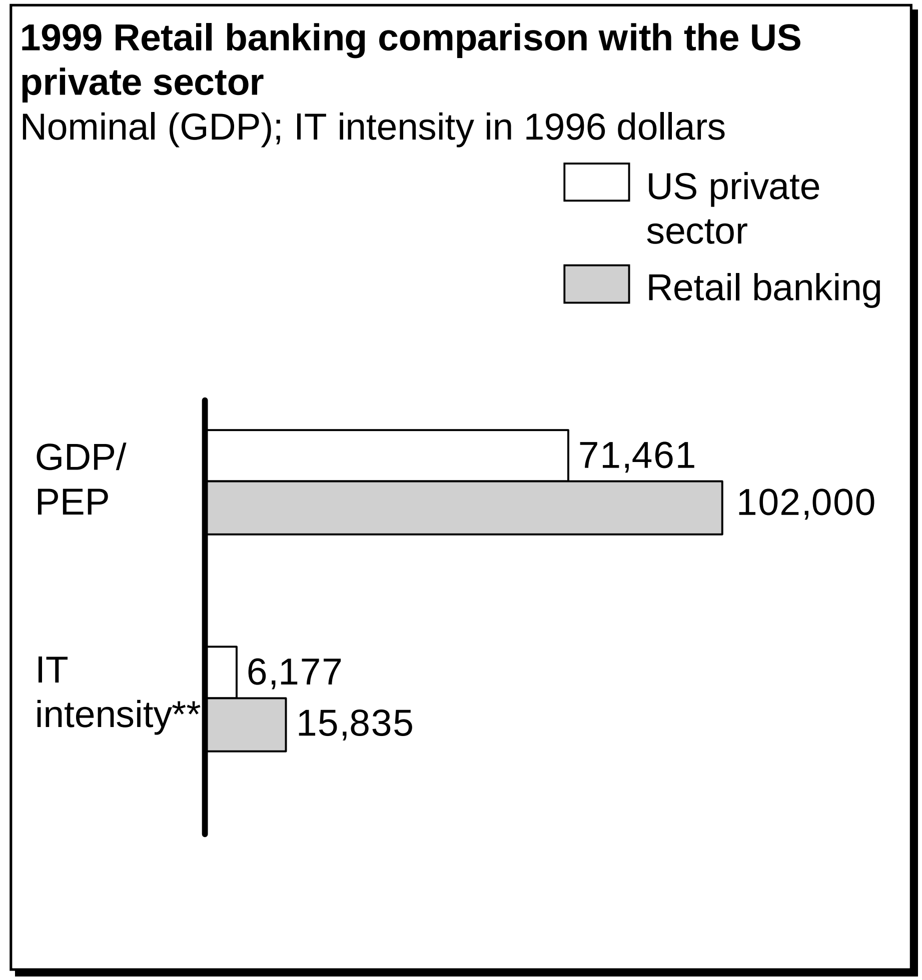
McKINSEY GLOBAL INSTITUTE

Exhibits for Retail Banking Write-up
October 3, 2001

Exhibit 1

RETAIL BANKING HAS HIGHER LABOR PRODUCTIVITY THAN OVERALL US ECONOMY





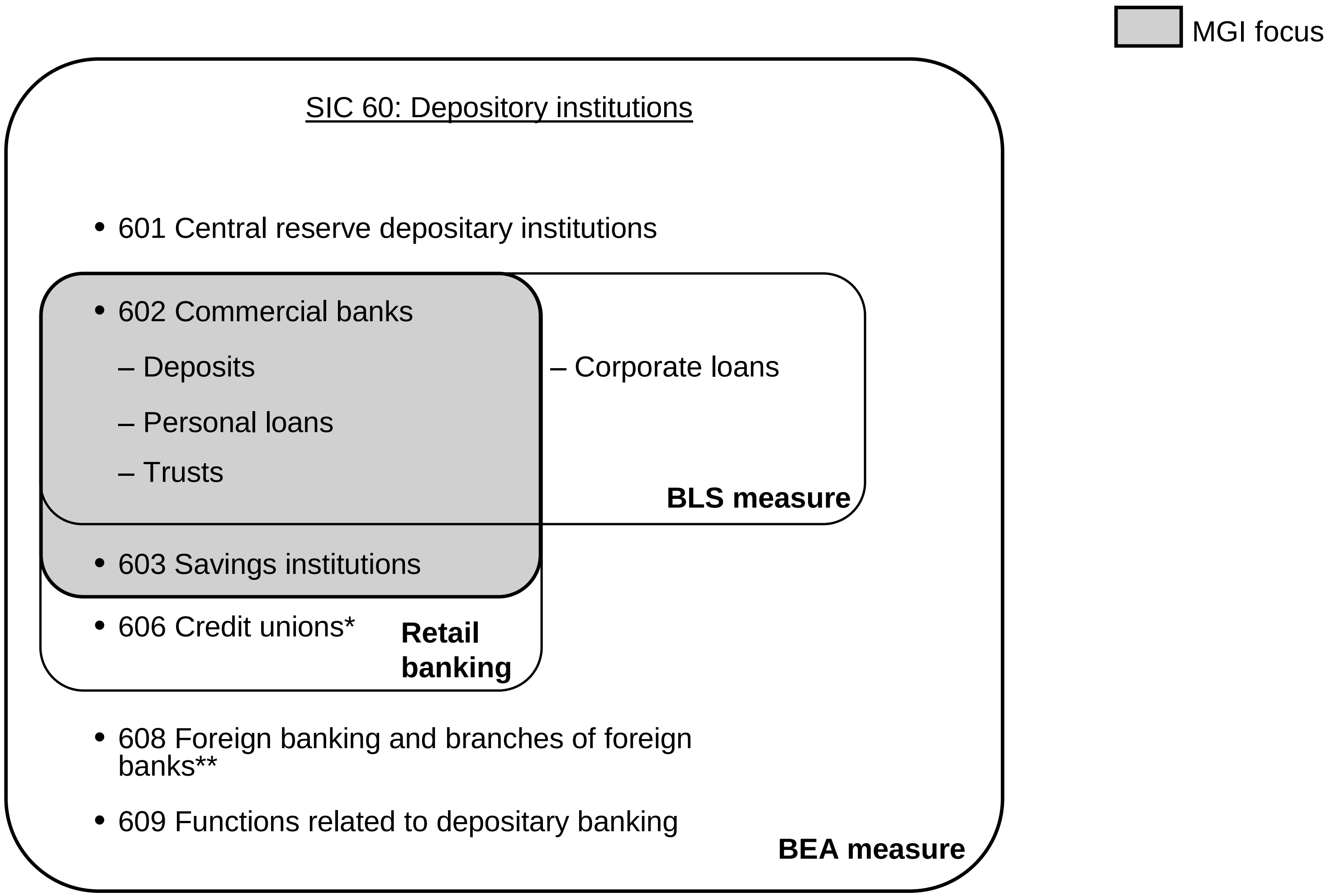
* Employment and GDP data for retail banking is calculated from BLS and FDIC data for retail deposits and transactions, lending, and fiduciary activities

. ** BEA data for depository institutions for 1996

Source: BEA; BLS; MGI analysis

Exhibit 2

MGI MEASURE OF RETAIL BANKING INCLUDES COMMERCIAL BANKS AND SAVINGS INSTITUTIONS



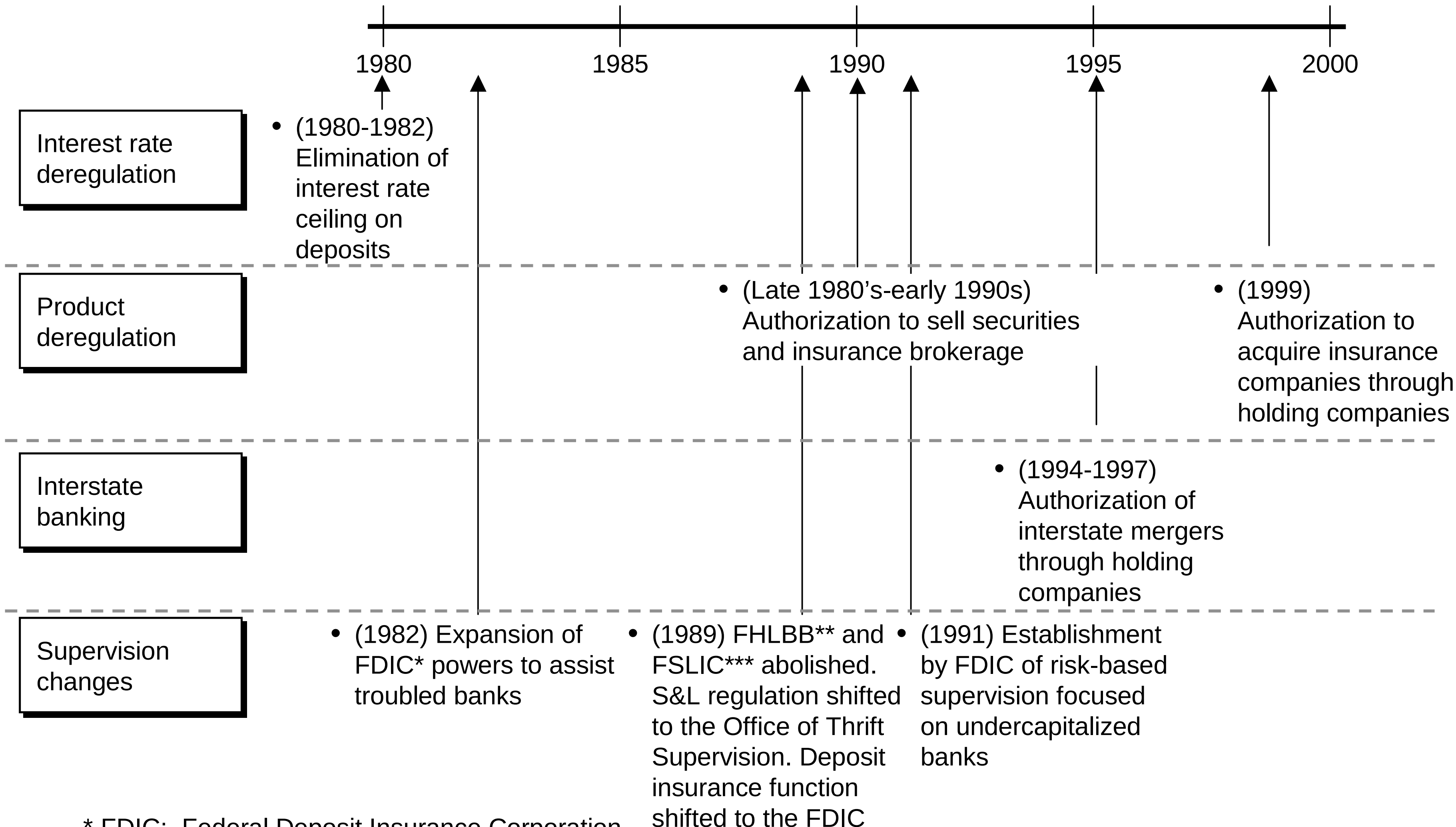
* While credit unions are part of the retail banking sector definition, they are not included in the MGI measure because available data is limited

** Foreign banks accepting retail deposits from the general public are classified under SIC 602-Commercial banks

Source: SIC index; MGI analysis

Exhibit 3

RETAIL BANKING HAS UNDERGONE SEVERAL WAVES OF REGULATORY CHANGES



* FDIC: Federal Deposit Insurance Corporation

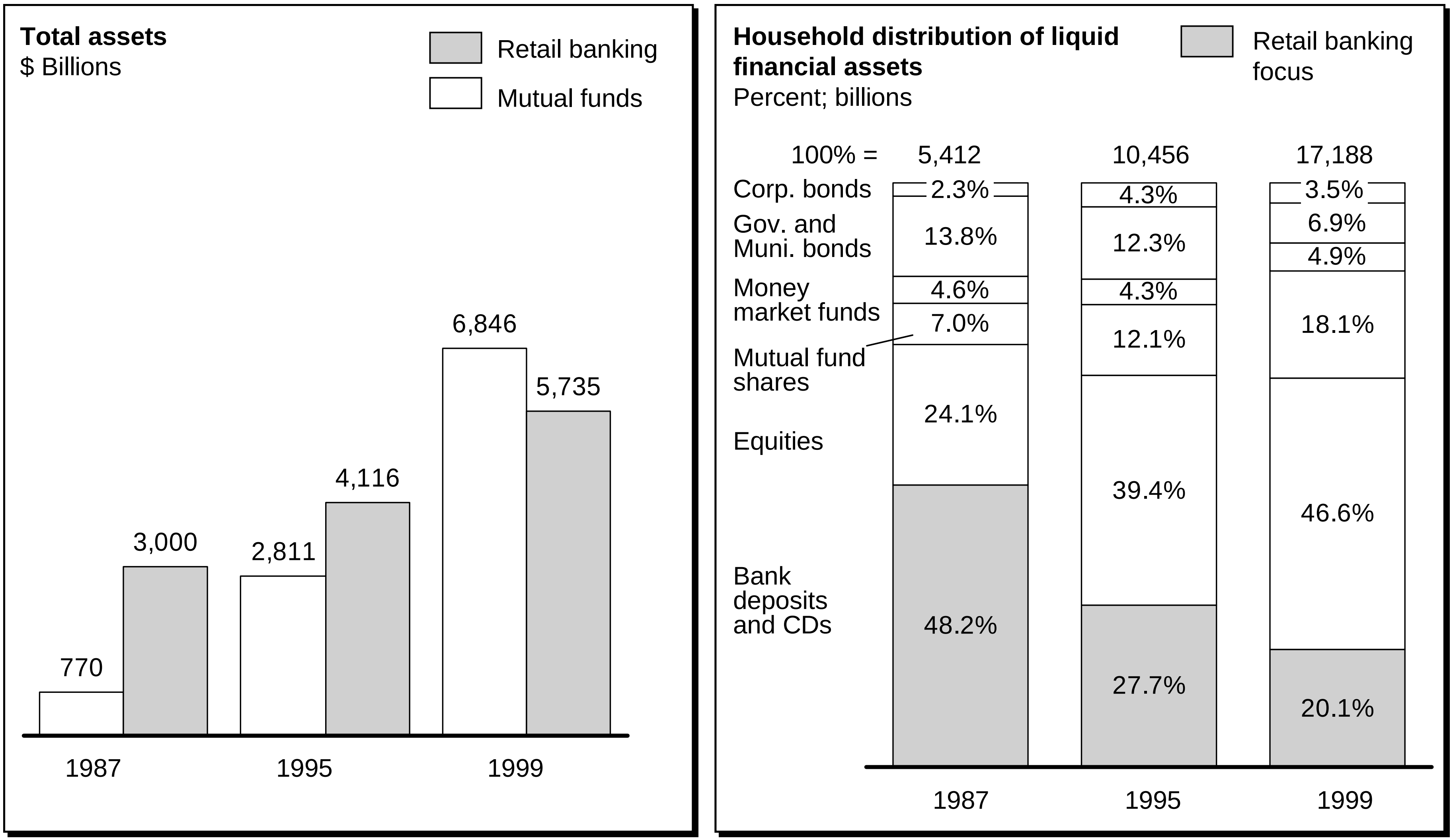
** FHLBB: Federal Home Loan Bank Board

*** FSLIC: Federal Savings & Loan Insurance Corporation

Source: Federal Reserve; MGI analysis

Exhibit 4

RETAIL BANKING'S SHARE OF FINANCIAL ASSETS HAS DECREASED SINCE 1987

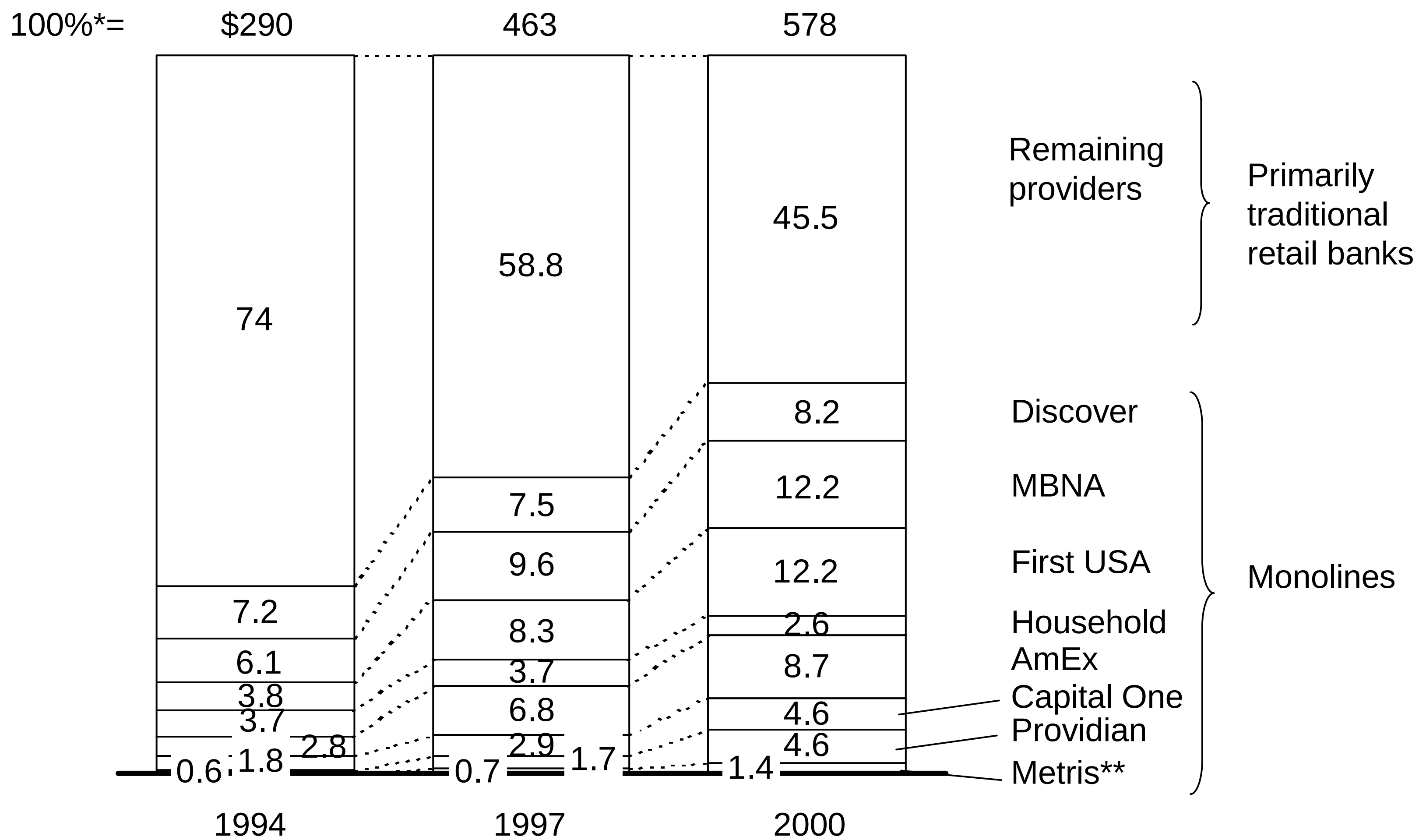


Source: Federal Reserve; ICI

Exhibit 5

TRADITIONAL BANKS HAVE BEEN LOSING MARKET SHARE TO MONOLINES

Percent; $ Billions



* 100% represents total credit card balances outstanding

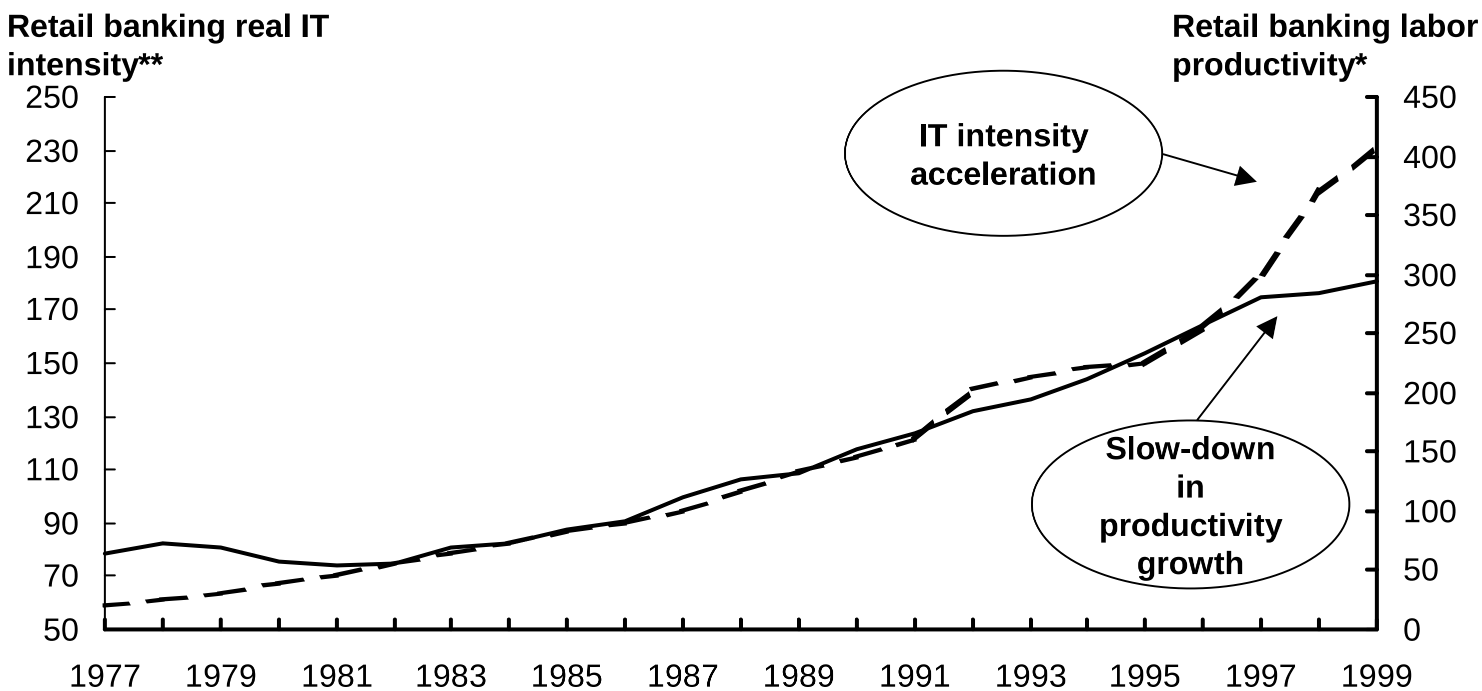
** Metris market share in 1994 was close to zero

Source: Nilson Report

Exhibit 6

SINCE 1995 RETAIL BANKING LABOR PRODUCTIVITY HAS SLOWED AS IT CAPITAL INTENSITY HAS ACCELERATED

Index 1987 = 100



	CAGR 77-82	CAGR 82-85	CAGR 87-95	CAGR 95-99
Labor productivity	-1.1	6.1	5.5	4.1
Real IT capital intensity	21.5	12.6	11.4	16.8

* Labor productivity measured as real output (transactions plus loans plus fiduciary activities), divided by hours worked

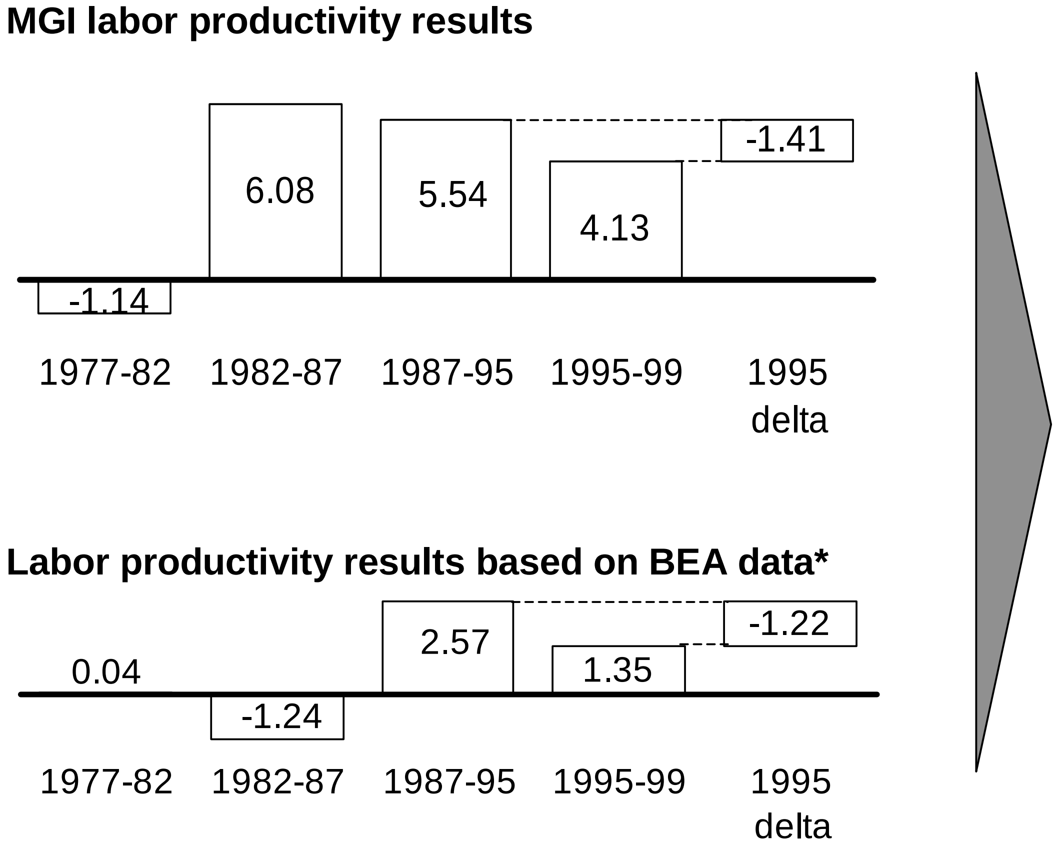
** Real IT intensity measured as real IT capital stock, divided by PEP. Estimated based on BEA data for depository institutions

Source: BEA; MGI analysis

Exhibit 7

RETAIL BANKING LABOR PRODUCTIVITY GROWTH RATES HAVE DECLINED SINCE 1982

CAGR



- Retail banking's period of most rapid productivity growth was 1982-87
- Labor productivity growth has been underestimated by official statistics

* BEA results for depository institutions. Note that BEA changed its methodology for calculating real value added for depository institutions in 1987

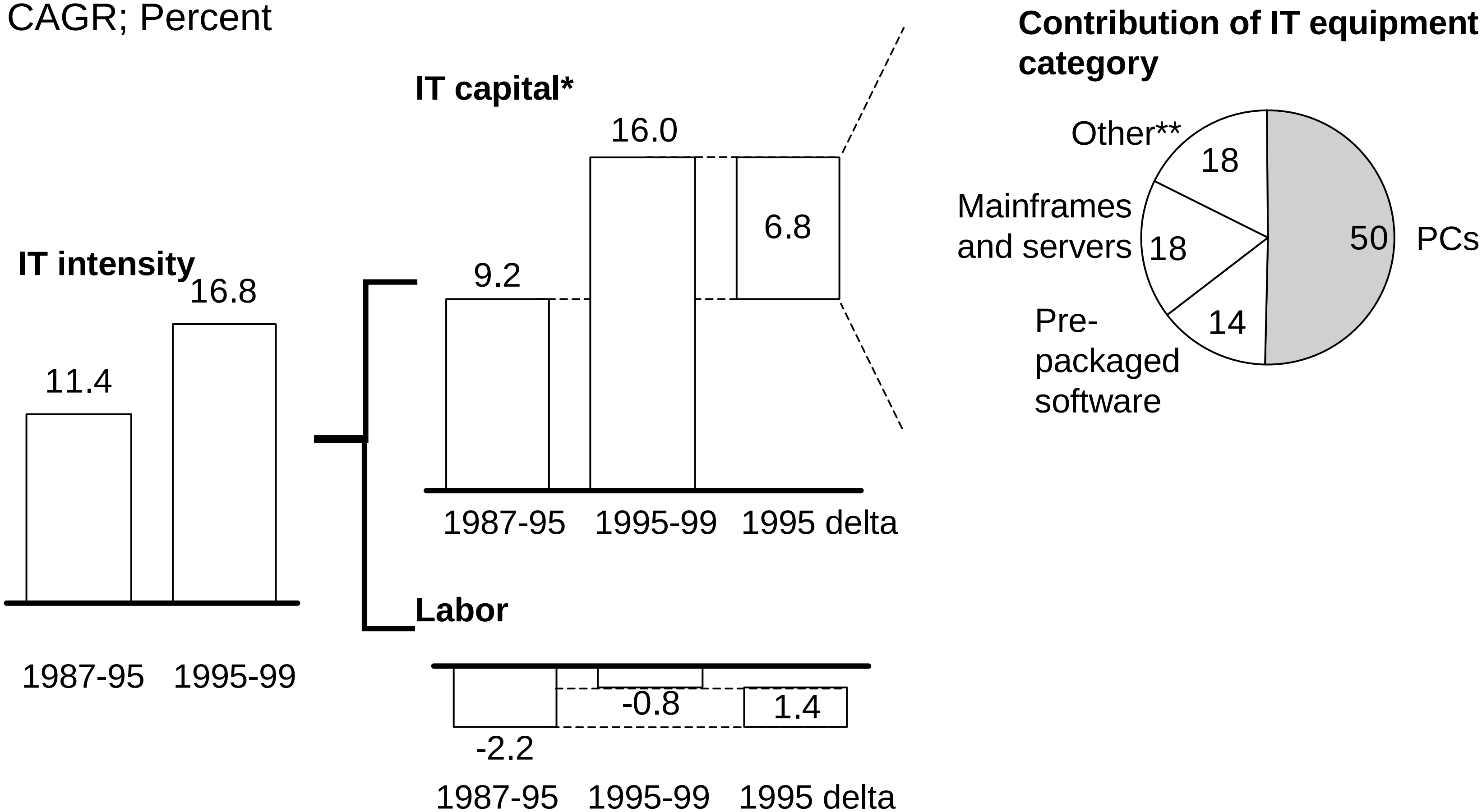
Source: BEA; BLS; FDIC; ABA; MGI analysis

Exhibit 8

BANKS' STRATEGIES LED TO INVESTMENTS IN THREE IT CATEGORIES

Increase in IT capital by IT equipment category

CAGR; Percent



* IT capital figures represent BEA data for depository institutions

** Other includes custom software (8.1%), computer peripherals (8.8%), computer storage devices (9.1%), computer terminals (5.5%), communications equipment (-17.8%), and other (4.2%)

Source: BEA; BLS; MGI analysis

Exhibit 9

BANKS' STRATEGIES DROVE IT INITIATIVES

Percent

CIO allocation of investment per strategy	Business strategy	Major IT initiatives*	CIO allocation of IT investment per initiative
40	• Customer information management, support and sales automation**	• Customer support, call management, projections and analytics tools, sales support and other CRM tools	15
15	• Mergers and acquisitions	• Customer data and systems integration	40
13	• Multichannel approach**	• On-line banking	13
12	• Product proliferation	• Other new functionality	27
15	• Other applications		
5	• Disaster avoidance	• Y2K investment***	5
Total 100			**Total = 100**

* Estimates include all direct and indirect IT investments in hardware software and communication equipment, excluding expenses

** Includes investments in additional mainframe processing power due to increases in transaction volume.

*** Y2K investment represents only half of total Y2K costs; the remaining half was an expense

Source: Information Week 500; Tower Group; Retail banking CIO/executive interviews; IDC; MGI analysis

Exhibit 10

SEVERAL FACTORS DROVE RETAIL BANKING IT PARADOX

◑ **Somewhat important** (10-50% of investment)

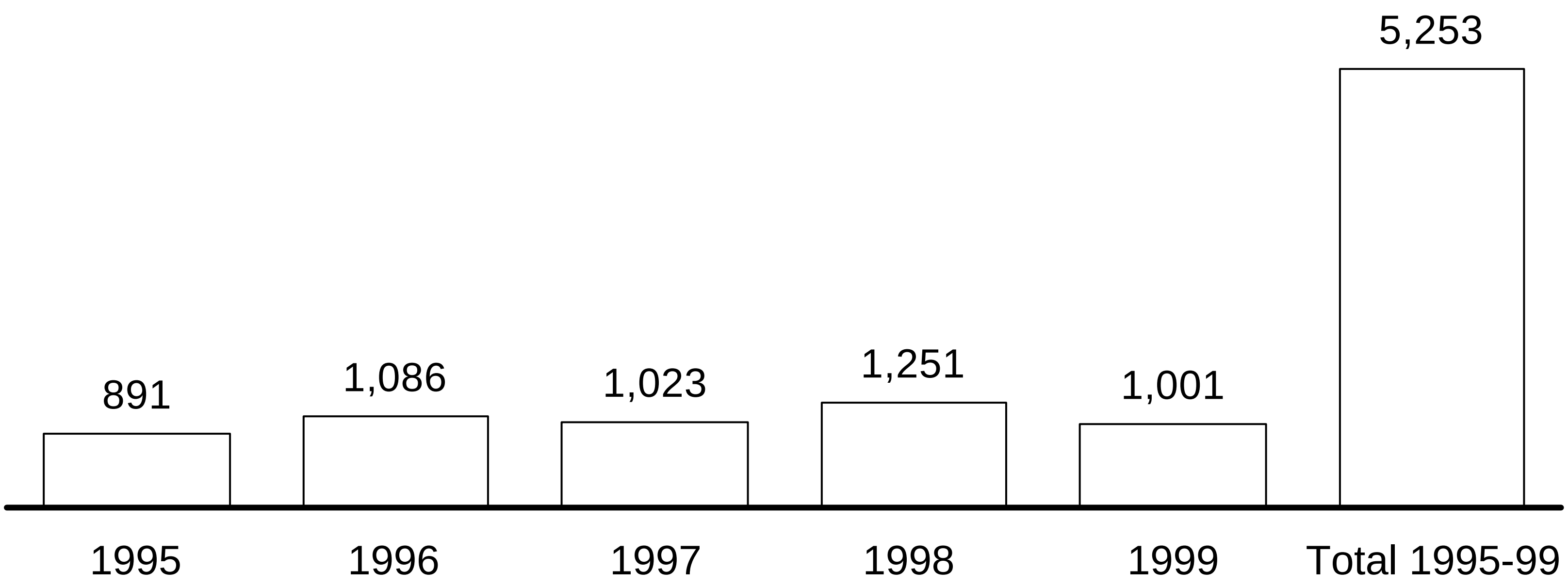
X **Not important** (<10% of investment)

		Retail banking	
External factors	• Capital markets / demand effects	◑	• High returns supported by non-interest income driven, in part, by buoyant financial markets
	• Product market regulation	◑	• Interstate banking deregulation facilitated merger activity. • The lack of a nationwide electronic payment system limits online savings potential
	• Y2K	X	
	• Unmeasured consumer benefits	◑	• Full benefits of online banking, automated call centers difficult to measure
Industry-level factors	• Low competitive intensity	◑	• Industry becomes more concentrated, and more profitable
	• Lower than expected demand	X	
Operational explanations for lack of productivity enhance-ment	• Unmeasured convenience to customers/surplus shift	◑	• "Arms race" benefits consumers (e.g., online banking, call centers)
	• Y2K compliance	X	• Necessary but not designed to enhance productivity
	• Software and hardware that did not yield expected returns	◑	• Disappointing CRM results to date • Complexity costs associated with bundling/pricing options whose consumer benefits are unclear to date • Merger integration costs have been significant with returns yet to come
	• Excessive/unnecessary investment	◑	• PCs purchased likely excessive in number and power

Exhibit 11

BANKS* PURCHASED ON AVERAGE TWO PCs PER EMPLOYEE DURING 1995-1999

PC investment per employee, nominal dollars



* Data for depository institutions

Source: BEA; MGI analysis

Exhibit 12

THERE IS EVIDENCE OF EXCESS CAPACITY IN PCs

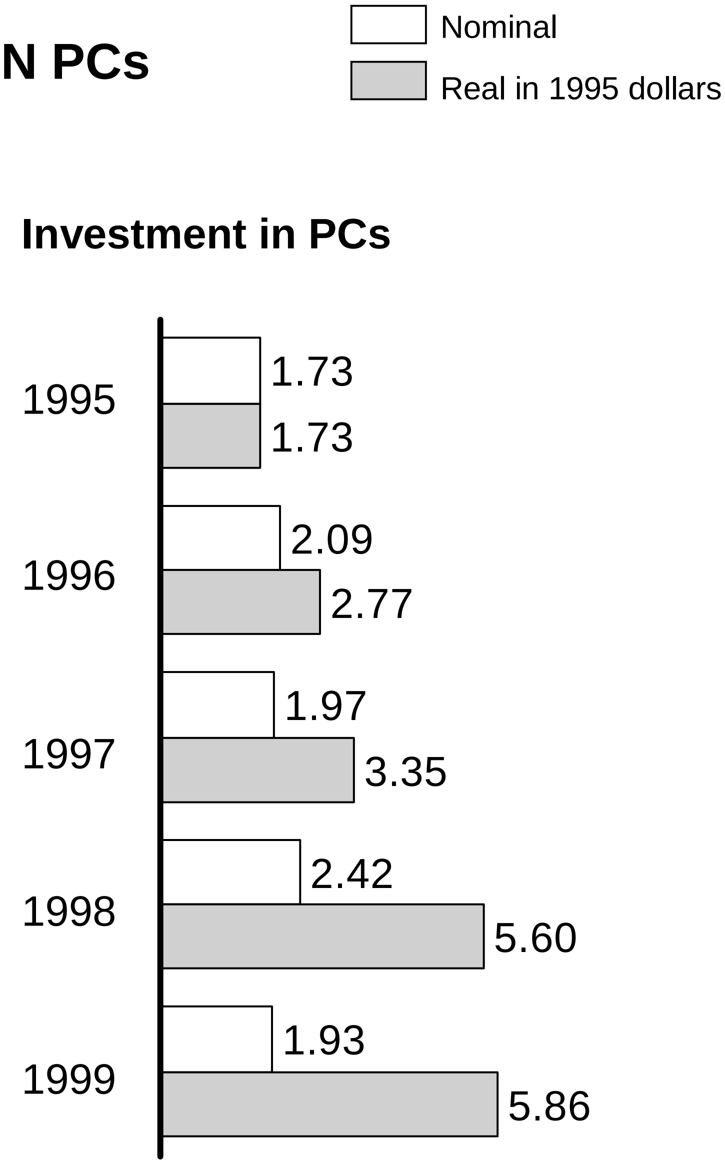
Interviewee quotes

"Although I am very pleased with the technology we deployed, we have not used all the capacity"

"If there is any place where there is excess capacity, it is damn sure on the desktop. You have a tremendous amount of power that you are using only 1% of"

"[Say I'm a manager.] I requisition a piece of software based on the full functionality it offers. As I cost justify it, I build more functionality into the cost or revenue justification for it. After the purchase, it is an open question whether the IT group has the ability to make that functionality available at the desktop with quality, where it can be a productive asset"

Investment in PCs



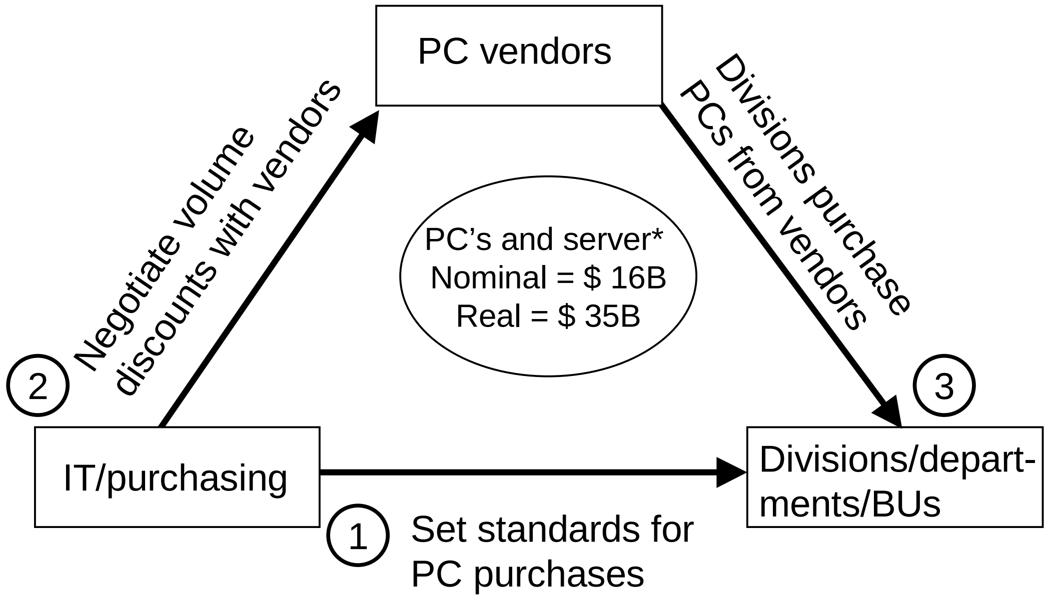
Source: Retail banking CIO/Executive interviews; BEA; MGI analysis

EXHIBIT 13

DYNAMICS OF PC PURCHASING CONTRIBUTED TO OVERINVESTMENT IN PCs

$ Billions

"There is a group rate. At Bank X, you buy 2000 PCs at a time from Dell. They all have the latest and greatest"



- "If I am a department manager, I do not care if it is a Pentium 3; I am buying it if it's the standard"
- "These purchases are capitalized. They don't hit your budget that much"

"Users buy on a corporate standard, which is measured against (high-end) usage . . . you are always buying more than you need because the standard is more than you need"

"In a big bank, you want standard PCs because you have standards for maintenance [particularly of software commonality through client-server deployment] and redeployment"

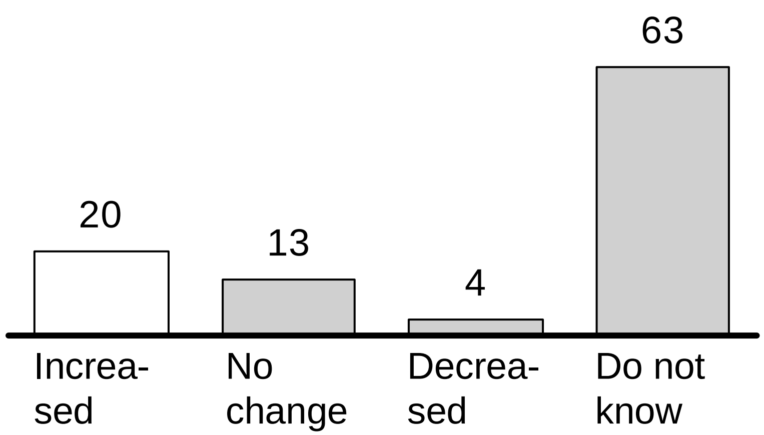
* Cumulative investment, 1996-1999; real numbers in 1996 dollars

Source: BEA; Retail banking CIO/Executive interviews

Exhibit 14

MOST CRM PROJECTS HAVE NOT ACHIEVED EXPECTED RETURNS

Impact of CRM – change in customer profitability
Percent of surveyed banks



80% of surveyed banks have not seen or are unsure whether CRM has increased customer profitability

CRM assessment from Gartner Group

"55 percent of projects that apply technology to selling [have] fail[ed] to deliver measurable benefits. During the next three years, this will grow to 85 percent."

CRM assessment from CIOs and banking executives

"Even today, the returns on data warehousing are dubious. Okay, technologists, you have built this for us. How do we use it?"

"A lot of the IT investment in retail banking has been in the area of customer acquisition, in a market that is not growing . . . The impact of this investment was stealing share, not growing the overall market . . . Almost by definition, such investments will drive down productivity"

"The way we deploy IT in our firm has created a shift in the way we do processes and practices. Anytime you see that shift or change, productivity will go down as people adjust to those new products"

"The jury is still very much out on CRM"

Source: E&Y Banking survey; Gartner Group; Stephen Brooks; Retail banking CIO/Executive interviews

Exhibit 15

PRODUCT PROLIFERATION DROVE COMPLEXITY AND HIGHER COSTS

Product proliferation leading to hardware investments

Example
"In 1994/95, there were a couple of credit cards, one at 17% interest, the other at 19%. When I left [last year] there were 43,000 pricing combinations they had to handle and that increased complexity. Each was considered a separate product"

Impact
"The complexity that goes through the software degrades its performance; the only thing that can improve it is to throw more MIPS at it . . . To deal with this we didn't just have to double computing capacity, we had to quadruple it"

Product proliferation leading to non-hardware expenses

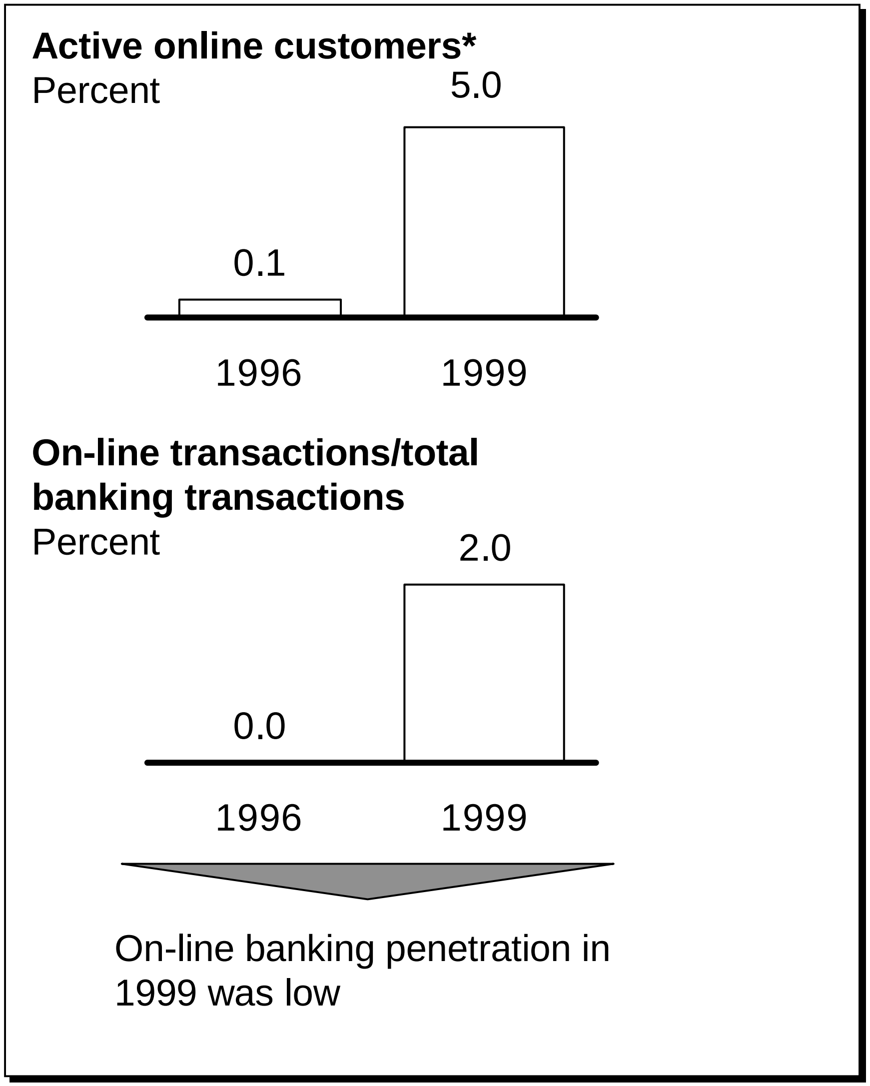
Example
"We are being driven to our product being a commodity; the real value has been the ability to package . . . for example, we are now doing dynamic bundles of our products so customers can chose any combination of products"

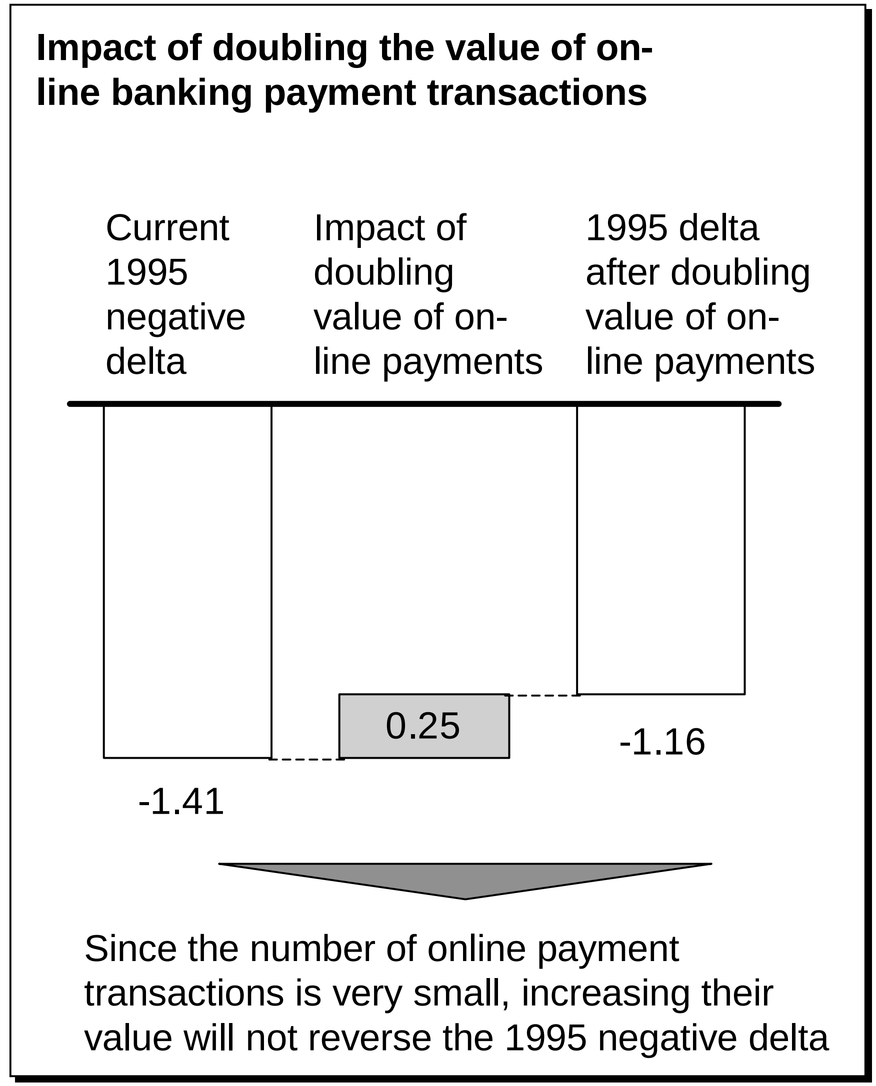
Impact
"All those combinations increase complexity. As systems get more complex you have a tremendous testing requirement, every single day a big part of our [maintenance] budget is testing to make sure that the new stuff you're putting in is not impacting [old] code. That's where a lot of spending is going"

Source: Retail banking CIO/Executive interviews

Exhibit 16

IMPACT OF ONLINE BANKING ON RETAIL BANKING LABOR PRODUCTIVITY HAS BEEN LOW



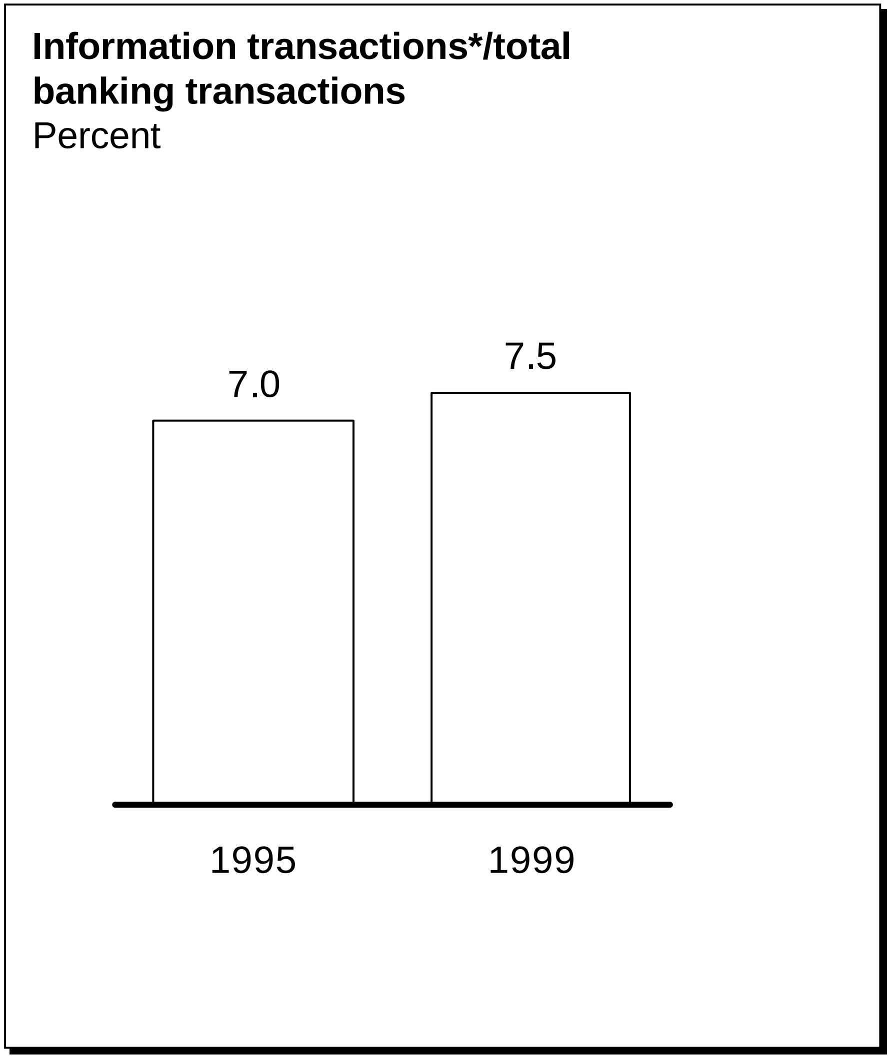


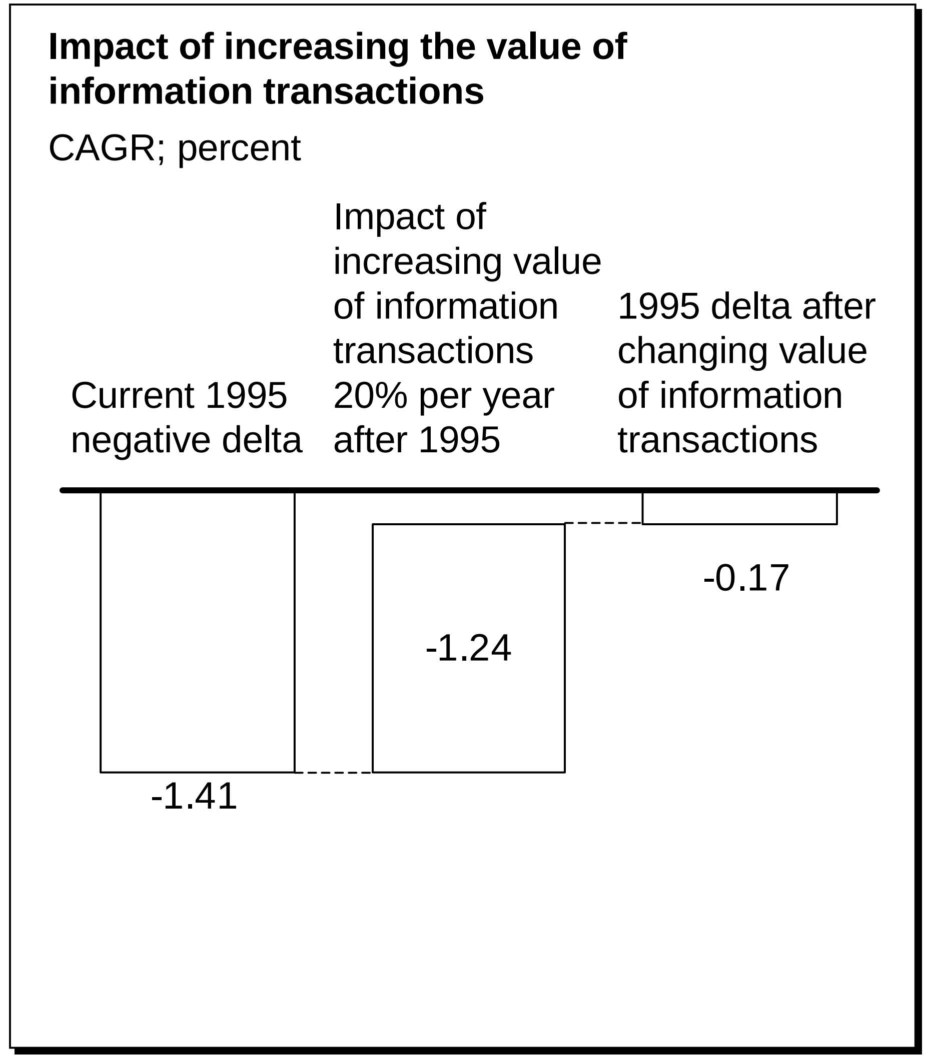
* Active online customers defined as customers who access their on-line account more than once a month

Source: On-line banking review; ABA

Exhibit 17

IMPACT OF INFORMATION TRANSACTION ON RETAIL BANKING LABOR PRODUCTION IS LOW





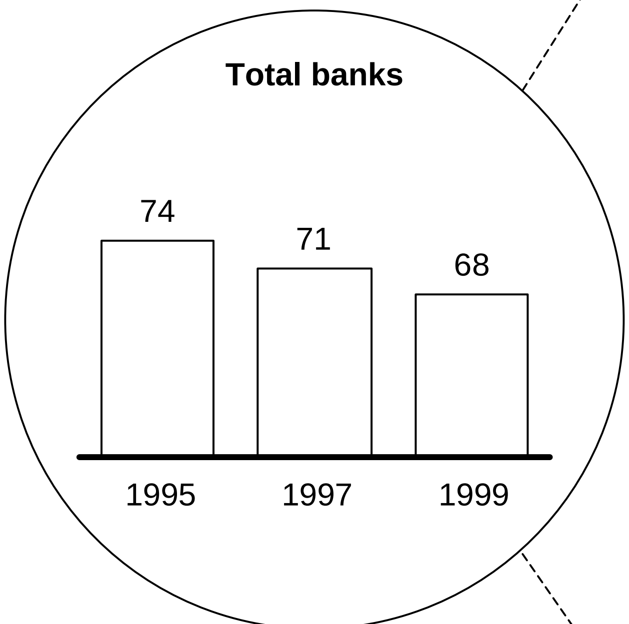
* Information transactions include call inquiries, on-line inquiries, and ATM inquires

Source: On-line banking review; Card Industry Directory; ABA

Exhibit 18

CUSTOMER SATISFACTION INDEX ACROSS THE BANKING INDUSTRY HAS DECREASED

Customer satisfaction index; percent



Consumer want banks to primarily deliver consistently on "the basics"

Importance rank*	**Attribute**	**How banks perform** Range = 0-5
1	Resolves problems quickly and correctly	3.3
2	Provides good customer service	3.6
3	Consistent performance	3.5
4	Is easy to do business with	3.5
5	Won't let you down if there is a problem	3.2
6	Provides good value	3.3
7	Reliable	3.7
8	Bank makes effort to build relationships	3.1
9	Caring	3.1
10	Trustworthy	3.7
11	Gives good advice	3.4
12	Has reasonable fees	2.7
13	Serves its customers in a timely manner	3.5
14	Flexible	3.1
15	Consistent service	3.5

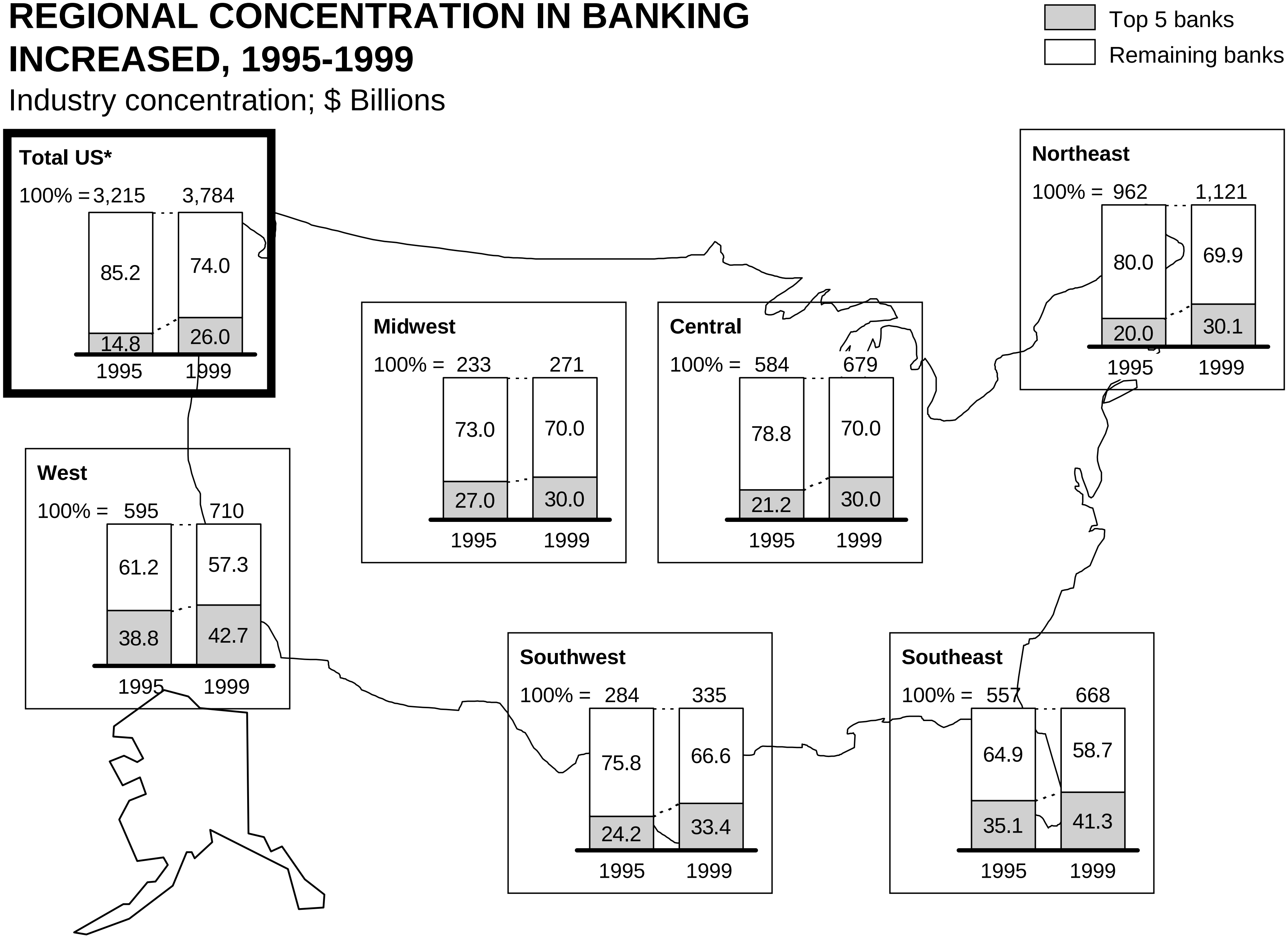
* Top 15 differentiated attributes out of a total of 49

Source: McKinsey Branding Practice; University of Michigan

Exhibit 19

REGIONAL CONCENTRATION IN BANKING INCREASED, 1995-1999

Industry concentration; $ Billions



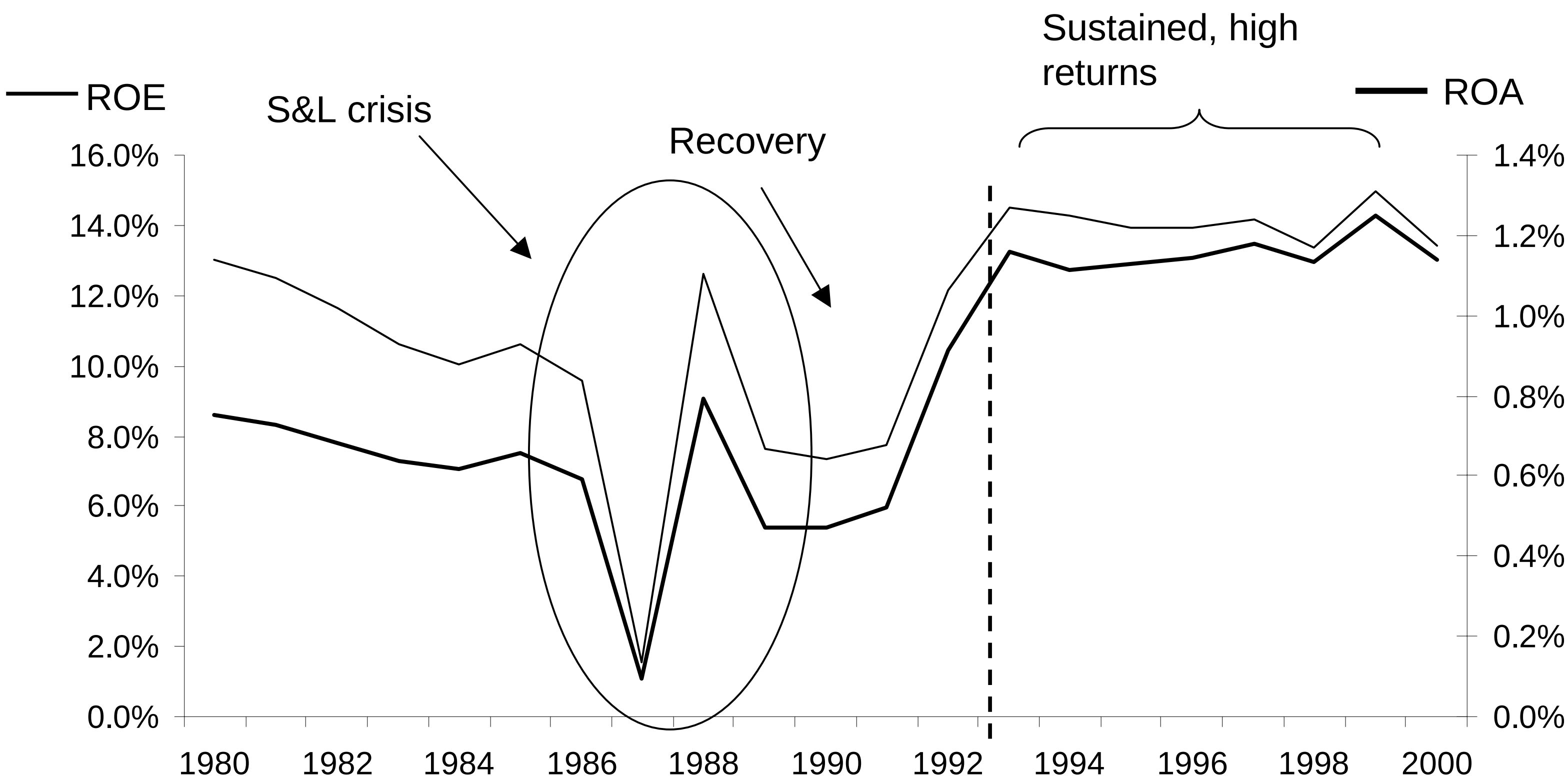
Source: FDIC domestic deposits data for commercial banks and savings institutions by holding company; MGI analysis

Exhibit 20

BANKING HAS BEEN HIGHLY PROFITABLE SINCE 1993

Commercial banks' returns, 1980-2000

Percent



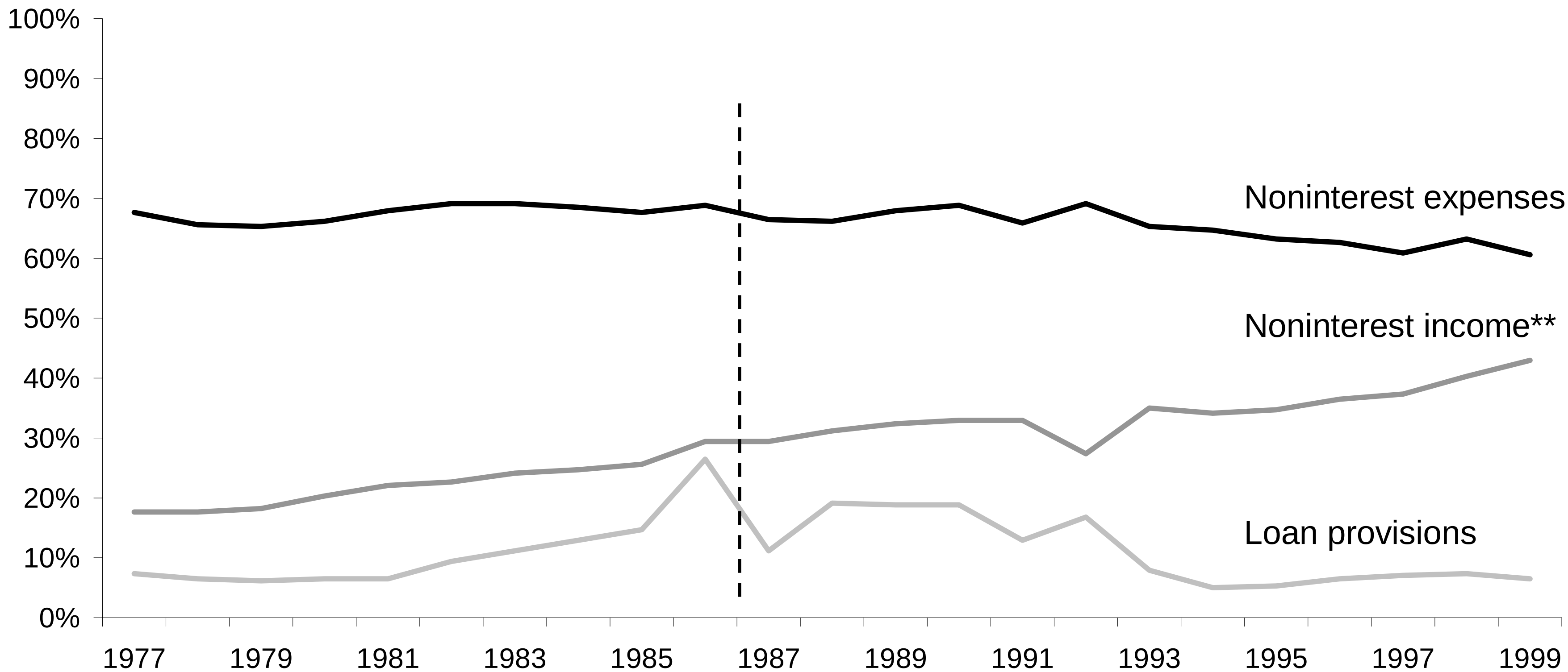
Source: FDIC

Exhibit 21

NONINTEREST INCOME WAS LARGEST CONTRIBUTOR TO INCREASED PROFITS AFTER 1993

Contributors to commercial bank's profits

Percent of total income



* Total income = net interest income + non interest income

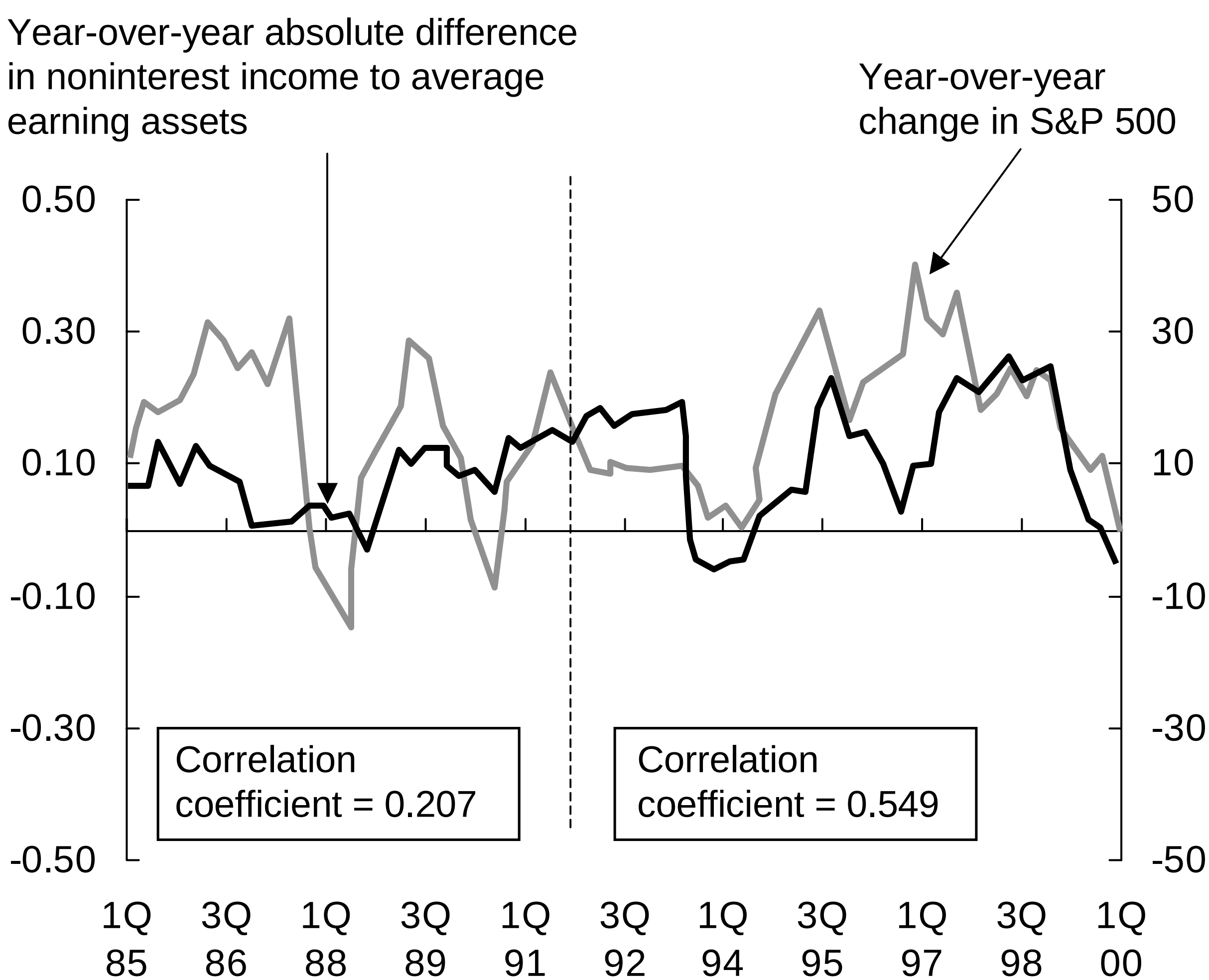
** Non-interest income includes fiduciary activities (14%), service charges on deposits (15%), trading account gains and fees (7%) and other non-interest income (64%), which includes investment banking, servicing fees, venture capital revenue, and gains on assets sold

Source: FDIC

Exhibit 22

NONINTEREST INCOME CORRELATES TO S&P 500 PERFORMANCE

Percent



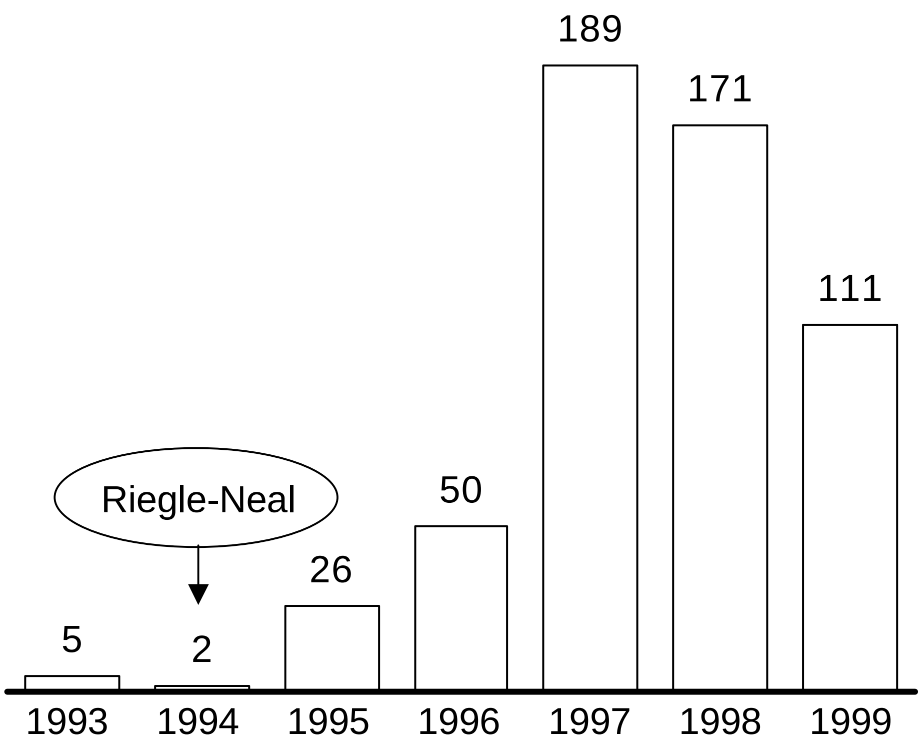
Time lag between changes in S&P 500 index and changes in noninterest income ratio of average earning assets has shortened

Source: FDIC

Exhibit 23

RIEGLE-NEAL ACT OF 1994* LED TO INCREASED CONCENTRATION IN BANKING INDUSTRY

Number of interstate mergers



- Interstate mergers usually involve larger banks than intrastate mergers; therefore, IT integration efforts are larger
- Interstate mergers require complex systems integration due to issues such as state regulations and changes in time zones

* Riegle-Neal Interstate Banking and Branching Efficiency Act (1994) allowed bank holding companies to acquire banks in any state starting in 1997

Source: FDIC

Exhibit 24

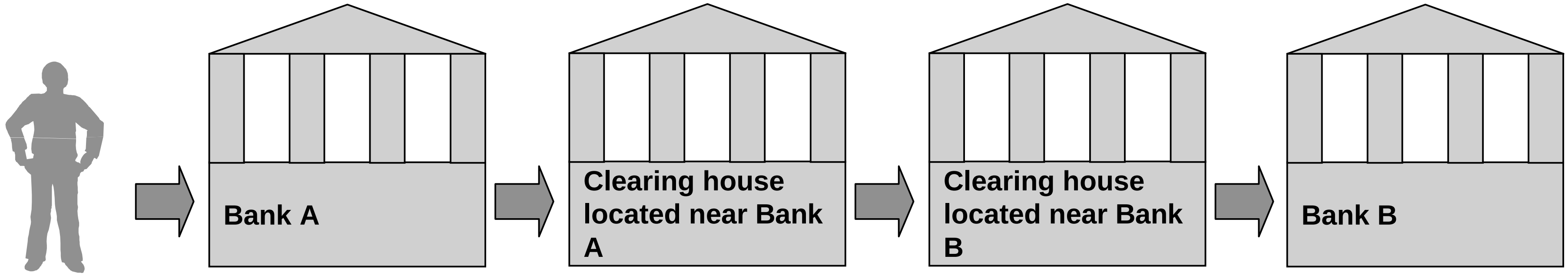
FUTURE PRODUCTIVITY BENEFITS FROM IT INVESTMENTS ARE UNCLEAR

Business approach	CIO/executive assessment	MGI assessment
Y2K	• Necessary investment • No functionality benefits	• Same
Channel proliferation (on-line banking)	• No cost savings to date, but could yield future returns when penetration increases	• Same
Mergers and acquisitions	• Should yield future cost savings	• Same
Product/price proliferation	• Has generated incremental revenue • Has increased complexity	• Returns tempered by increased complexity • Declining customer satisfaction, 1995-99, raises red flags
Customer-centric orientation / CRM	• Limited returns to date, but significant future promise • To date, has probably decreased productivity due to employee learning curve effects	• Evidence of declining customer satisfaction, 1995-99, calls into question current and perhaps even future returns on investment
	Few if any productivity enhancing investments to date, with future gains forthcoming	**Few if any productivity enhancing investments to date, with future performance uncertain**

Source: Retail banking CIO/Executive interviews; MGI analysis

Exhibit 25

IF CONSUMERS ORIGINATE THEIR CHECKS ELECTRONICALLY, BANKS COULD ELIMINATE UP TO 21% OF TOTAL TELLERS, CURRENTLY DEDICATED TO RECEIVE CHECK DEPOSITS



Retail customer deposits in branch* of Bank A

Bank A
- Receives and scans check number and amount, and prints the amount
- Deposits check at branch clearing house**

Clearing house located near Bank A
- Verifies check number and amount
- Sends check to clearing house branch

Clearing house located near Bank B
- Verifies check number and amount
- Sends check to Bank B
- Amount is credited to Bank A and debited from Bank B

Bank B
- Captures check information
- Debits consumer account
- Check is attached to monthly statement

Number of retail banking employees that could be eliminated if consumers shift to electronic payment

Check type***	Tellers/check processor	Check processors	Check processors	Operations/clerks
C-C checks	85,000 (21% of total tellers)	<1,000	<1,000	4,000
C-B checks (bill payments)****	<1,000	4,000	4,000	15,000
C-G checks	<1,000	<1,000	<1,000	<1,000

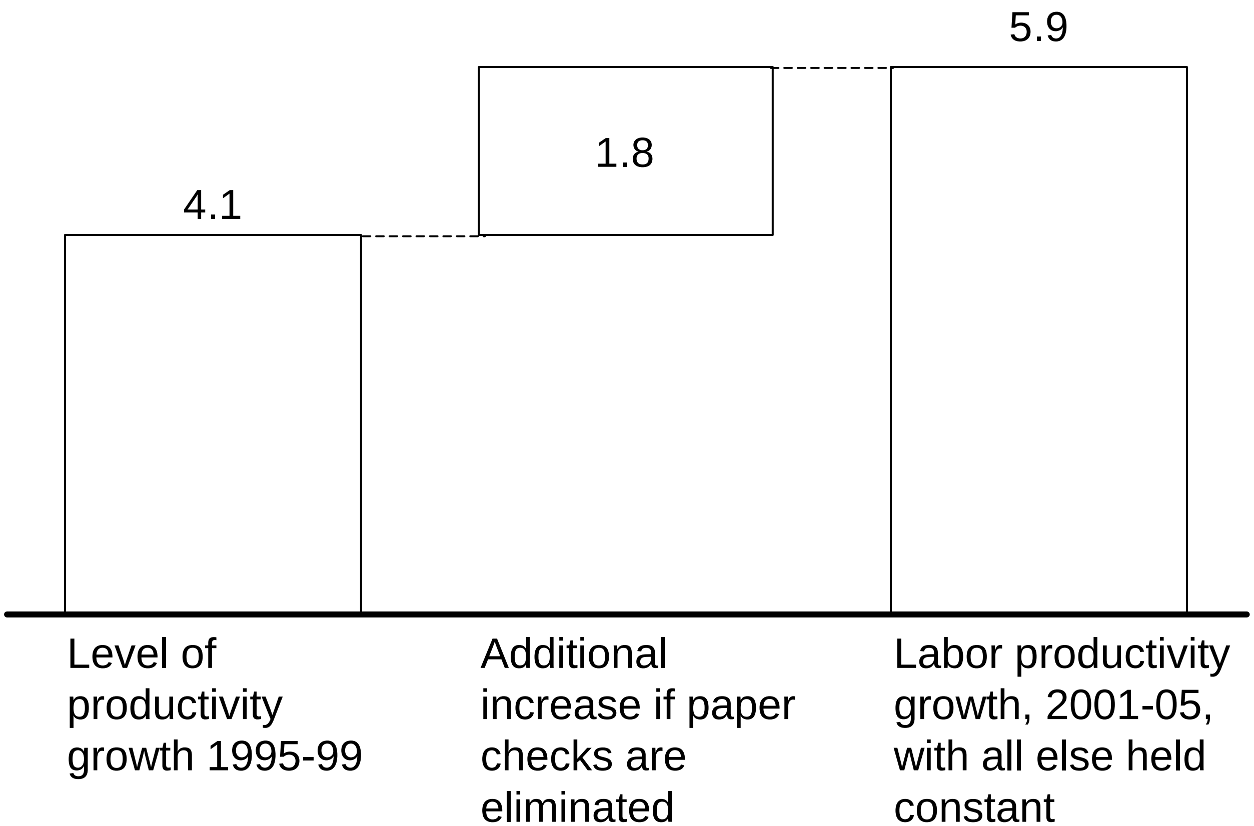
* Retail customers deposit the majority of their checks through tellers
** If check is truncated (an image of the check is sent instead of the check), subsequent steps are automated
*** C-C: Consumer to consumer; C-B: Consumer to business; C-G: Consumer to government
**** Represents 50% of total C-B total payments; includes monthly bill payments and excludes checks paid in stores

Source: GAO; Federal Reserve; MGI analysis

Exhibit 26

ELIMINATION OF PAPER CHECKS WILL INCREASE BANKING PRODUCTIVITY

Impact of consumers shifting from paper checks to electronic checks
CAGR; percent



Source: MGI analysis

APPENDIX

Exhibit A1

COMPETITIVE INTENSITY DROVE BANKING LABOR PRODUCTIVITY JUMP, 1982

● Important (>50% of acceleration)

◐ Somewhat important (10-50% of acceleration)

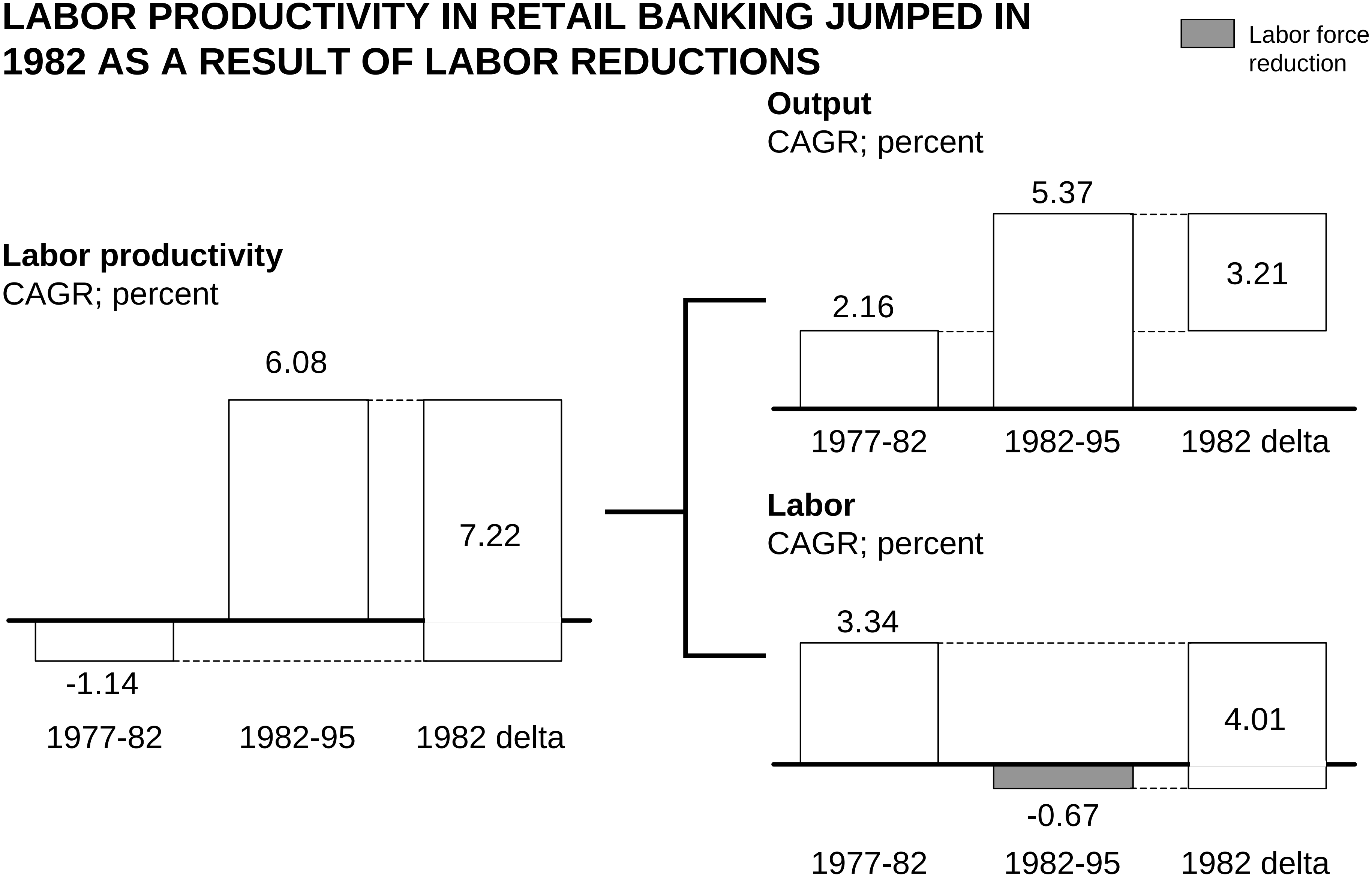
X Not important (<10% of acceleration

			Retail banking
External factors	• Demand factors (Macro-economic/financial markets)	◐	• Reduction in interest rates following a period of high rates helped the real estate lending market
	• Technology/innovation	◐	• Credit card and ATM transactions achieved critical mass in the 1980's
	• Product market regulation	●	• Deregulation of interest rates allowed banks to compete with money market funds
	• Up/downstream industries	X	
	• Measurement issues	X	
Industry dynamics	• Competitive intensity	●	• Banks began competing on price and focusing on cost reduction initiatives
	• Prices/demand effects	X	
Firm-level factors	• Output mix	X	
	• Capital/technology/capacity	X	
	• Intermediate inputs/technology	X	
	• Labor skills	X	
	• Labor economies of scale	◐	• ATM and credit card transactions increased with limited labor increase fixed loan processing labor was leveraged
	• OFT/Process design	●	• Excess labor was eliminated • Back-office operations were centralized

Source: MGI analysis

Exhibit A2

LABOR PRODUCTIVITY IN RETAIL BANKING JUMPED IN 1982 AS A RESULT OF LABOR REDUCTIONS



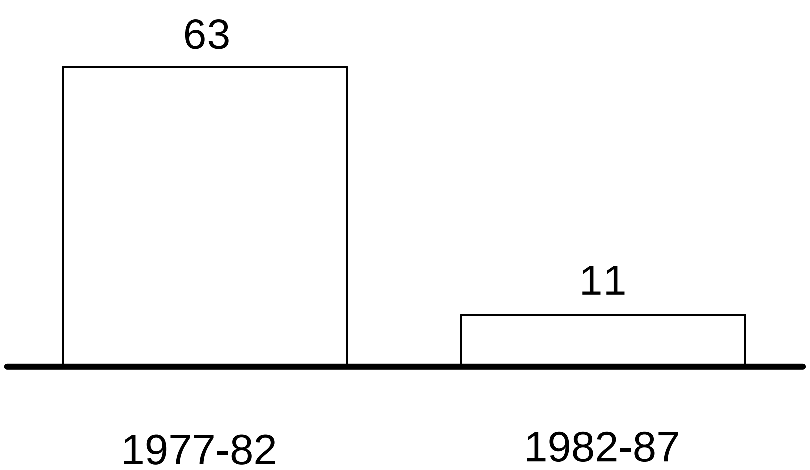
Source: BLS; FDIC; BEA; MGI analysis

Exhibit A3

IT INVESTMENT IN MAINFRAME SYSTEMS INCREASED DURING 1977-82

Investment in mainframes

CAGR; Percent



- Banks invested heavily in mainframes in the late 1970s to automate operations, centralize back-office operations, and reduce labor

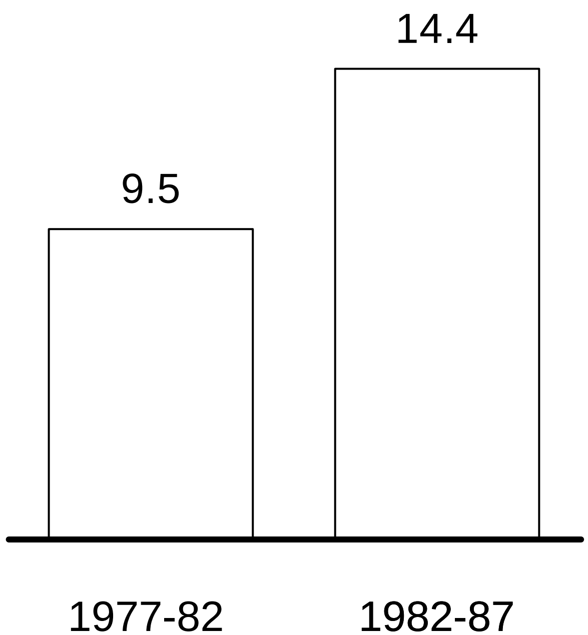
- Investments slowed in the 1980s as banks reaped the benefits of past investments

Source: BEA; MGI analysis

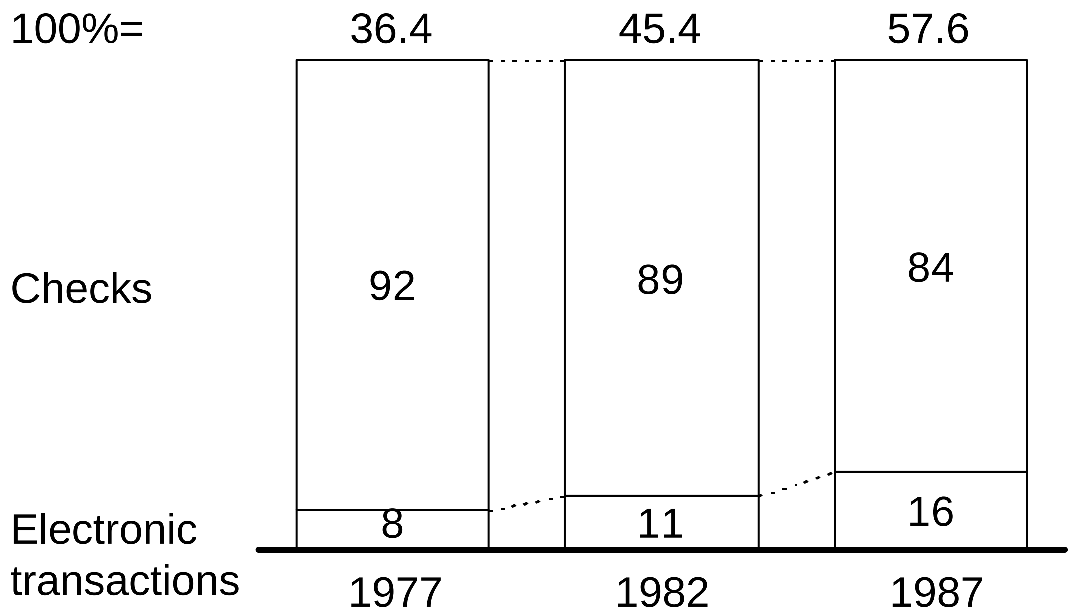
Exhibit A4

GROWTH RATE OF ELECTRONIC TRANSACTIONS ACCELERATED DURING THE 1980s

Growth rate of electronic transactions
CAGR; percent



Transactions
Billions



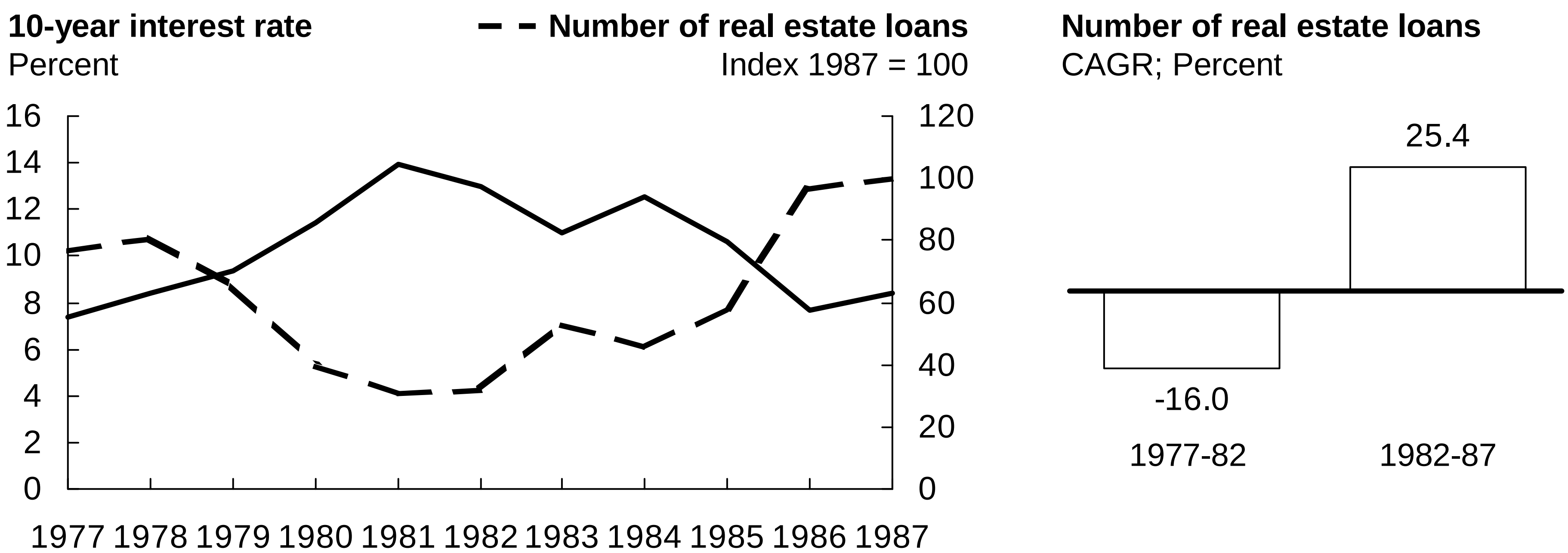
Growth of electronic transactions (credit card, ATM), which required limited variable labor, helped boost productivity

Source: BLS; ABA; International Bank of Settlement; MGI analysis

Exhibit A5

NUMBER OF REAL ESTATE LOANS ROSE AS INTEREST RATES FELL,1982-1987

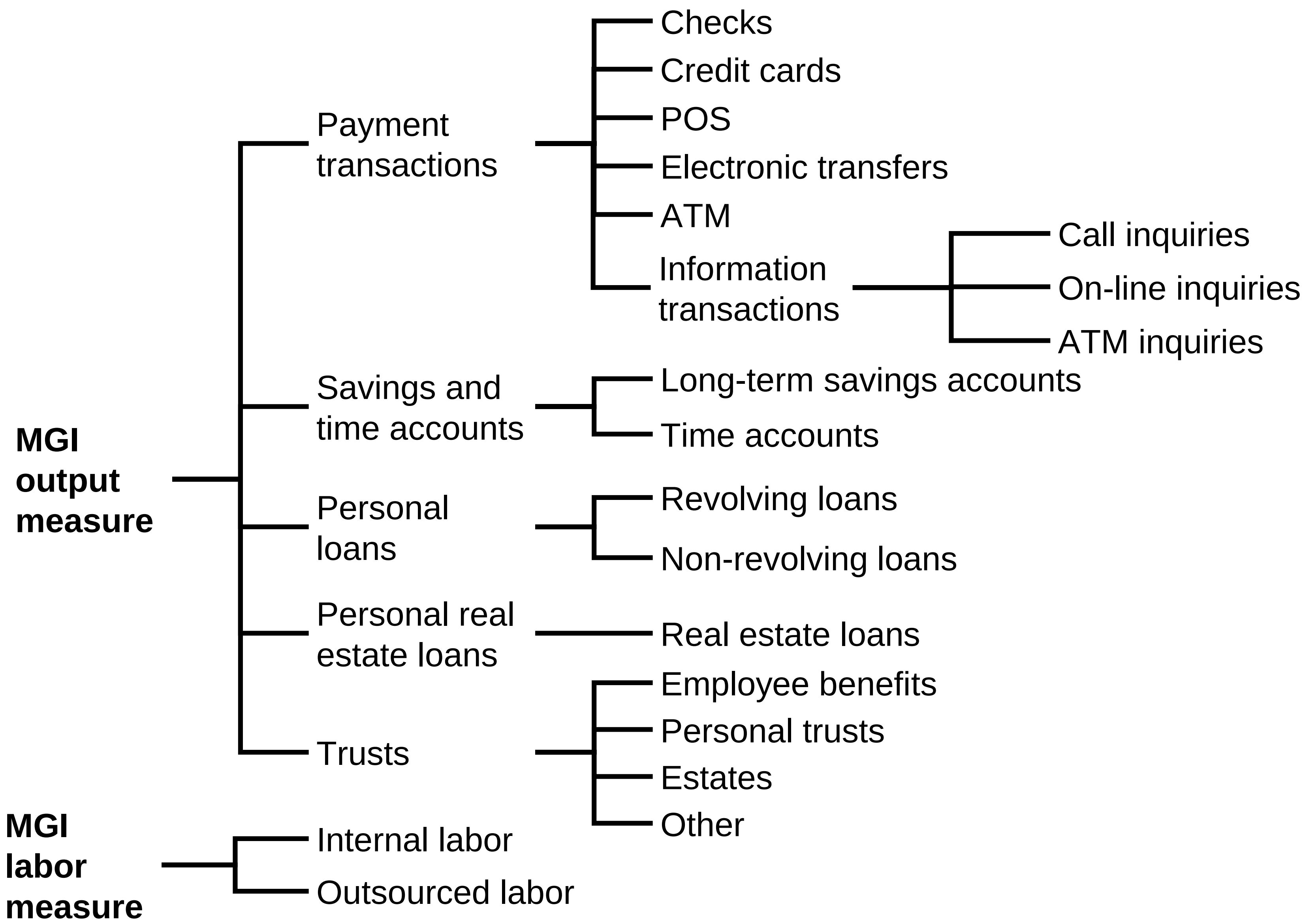
Changes in the growth rate of real estate loans



Source: BLS; Federal Reserve

Exhibit A6

MGI LABOR PRODUCTIVITY MEASURE



Hotels

SUMMARY

The US hotel industry's productivity performance and information technology (IT) investment pattern present a paradox: despite accelerated investment in IT equipment, hotels have not improved the labor productivity of room operations since 1995.

In an effort to enhance revenue through increased occupancy and customer loyalty, hotels invested heavily in property management, central reservation systems, and related applications (CRM and revenue management). Though not intended to eliminate labor, these applications were expected to yield more revenues and improve guest service without a commensurate increase in staff, thus increasing productivity.

However, several factors prevented these investments from having a significant impact on labor productivity:

¶ Some installed IT applications remain unused. Therefore, their impact on guest service and productivity remains negligible or unproven at best.

¶ Year 2000 and integration spending added no new functionality.

¶ There may be low potential for technology-enabled productivity gains.

¶ Some IT-generated consumer benefits were not captured by productivity measures.

The context in which this investment took place is also meaningful. Hotels' record high profitability in the late 1990s may have reduced pressure on management to take full advantage of their IT capability and improve productivity. High profits appear to have been driven primarily by a macro demand surge that allowed hotels to inflate prices, particularly in high-occupancy markets such as New York, San Francisco, and Boston for which the supply response was slow.

Hotels need to be conscious of the limits to their technology. Hotel work is no longer amenable to productivity-improving automation, and revenue growth – the stated aim of IT investment – was strong for all hotels after 1995, regardless of how they used IT. Hotels should look beyond IT for sustainable sources of productivity and financial performance improvement.

INTRODUCTION

The inclusion of the hotel industry in an exploration of IT's contribution to US labor productivity performance may seem surprising. While other chapters have focused on IT producers (computer and semiconductor manufacturing), heavy IT users (telecommunications, securities, retail banking), or extremely large sectors (retail and wholesale trade), hotels are none of the above. To oversimplify, hotels employ buildings, beds, and housekeepers to provide travelers with a place to sleep away from home – hardly a breeding ground for technological breakthrough.

Despite its “old economy” nature, the hotel industry did jump on the IT bandwagon after 1995, greatly accelerating its rate of IT investment. However, hotels did not experience a simultaneous improvement in productivity.

By resolving this apparent paradox for the hotel sector, we hope to shed light on the role of IT in US productivity improvement. In particular, we seek to understand the contribution of IT to recent labor productivity acceleration and to highlight barriers to the application of IT to productivity improvement.

OVERVIEW OF THE HOTEL INDUSTRY

Before turning our attention to the specific nature of the hotel industry IT-productivity paradox, we will discuss hotels more generally. After providing a brief industry overview – size, structure, and major activities – we place this case study into the context of the broader questions the McKinsey Global Institute (MGI) has sought to answer in this report.

Industry profile

The hotel industry involves a significant share of US employment, but has had a lower level of labor productivity growth than the US average (Exhibit 1).

- Despite consistently encompassing 1.5 percent of US private sector employment, hotels comprised only 1 percent of GDP in 1999.
- Hotels are also not very IT intensive, accounting for just under 0.3 percent of US private-sector IT investment in 1999. Real hotel IT intensity was $1,218 per worker in 1996, less than a fifth of the US private sector average of $6,177.

¶ Hotels did, however, participate in the economywide investment surge from 1995-99 as much as IT-intensive industries – their share of IT investment remained constant throughout.

The hotel industry derives the majority of its revenue (60 percent) from selling room nights and employs the majority of its workers (55 percent) to perform tasks related to this, with housekeepers and front desk workers being the most significant (Exhibit 2). However, the industry includes a wide range of establishments – from small, economically priced motels with few amenities, to full-service luxury hotels and casinos. As a result, other nonroom services, such as providing guests with meals/drinks and gambling facilities, also constitute a considerable share of industry revenue and employment.

Hotel companies typically follow four operational models: branded management company, nonbranded management company, pure franchiser, and pure property owner.

¶ Branded management companies (such as Marriott, Starwood, and Hilton) handle all day-to-day operations at hotel properties and also provide centralized reservations and marketing services. They are typically compensated by hotel owners based on some combination of property revenue and profitability. Sometimes branded management companies also own the properties they manage.

¶ Nonbranded management companies handle all day-to-day operations at the property, but rely on franchisers (who own the hotel brands) to provide centralized reservations and national marketing. This category of company includes both large nonbranded management companies such as Meristar and small owner-operators who own/run a franchised or independent hotel.

¶ Pure franchisers (Cendant and Choice are the largest, by rooms) own hotel brands and lease the use of that brand to property owners. They operate centralized reservations centers and conduct national marketing campaigns on behalf of their properties. Franchisers receive a fraction of hotel revenue in return for these services and the use of their brand.

¶ Pure hotel owners are typically real estate companies that own several different types of properties, often with no day-to-day management role. They do, however, approve major capital investments made by properties. Firms primarily engaged in real estate ownership (but not hotel management or franchising) are not included in our analysis.

The industry is fragmented, with the top chains representing only 36 percent of properties and 58 percent of rooms. However, since most of this reach is achieved through franchising, hotel ownership is even less concentrated (Exhibit 3). Some 32 percent of all US rooms are in hotels unaffiliated with a chain. Due to this fragmentation and the nature of the product (very perishable, fixed supply in the short run), the hotel industry is typically very competitive.

The major activities involved in renting hotel rooms are sales and marketing, reservations, guest check-in/out, room cleaning, and back-office functions. Due to the owner-manager-franchiser industry structure, responsibility for several of these activities lies at both the hotel property and chain central office (Exhibit 4). For instance, a guest can make a reservation in many ways: drop into or call the property, call the chain's 1-800 number, book on-line, or book through a travel agent.

Importance of the hotel industry to the overall question

The US hotel industry's productivity performance and IT investment pattern present a paradox: despite accelerated investment in IT equipment, hotels have not improved the real labor productivity of their rooms operations since 1995 (Exhibit 5).[1]

¶ After growing at 0.7 percent annually from 1987 to 1995, labor productivity growth slowed to zero after 1995.

¶ This productivity stagnation occurred despite a surge in IT investment, which greatly increased the amount of real IT capital employed per worker more than 10 percent annually after 1995, five times faster than its 1987-95 rate of growth.

The hotel industry's poor recent productivity performance (despite its increased use of IT) raises several questions:

¶ Did IT investments cause improvements in productivity that were masked by other (negative) factors?

¶ If IT investments did not enhance productivity, why were they made and were they wise?

¶ Are some benefits of IT not captured in productivity measures?

¶ What external and industry-specific factors influence the role that IT can play in improving productivity?

[1] Real labor productivity is defined here as the number of quality-equivalent room-nights sold for every hour worked by employees in the rooms operation (housekeepers, front desk workers, bell hops, managers, etc.). Room price increases that do not reflect service improvements are not considered productivity-enhancing.

By answering these questions specifically for hotels, we hope to shed light on the role IT plays in US productivity improvement more broadly. In particular, we seek to understand the contribution of IT to recent labor productivity acceleration and to highlight barriers to the application of IT to productivity improvement.

LABOR PRODUCTIVITY PERFORMANCE

MGI calculates hotel labor productivity as the number of quality-equivalent room-nights sold for every hour worked by employees in the rooms operation (housekeepers, front desk personnel, bell hops, managers, etc.). Our output measure is derived by deflating room revenues by a quality-adjusted price index available from the US Bureau of Labor Statistics (BLS).[2] (See Appendix 1 for further methodological details and data sources.)

- Room price increases that do not reflect service improvements are not considered productivity enhancing.
- This measure does not encompass the entire array of hotel activities (food/beverage and gambling are excluded). A narrow output scope eliminates any productivity changes associated with mix shifts toward less or more productive services (food and gaming, respectively).
- Though a productivity measure using value-added for output is preferable for several reasons (see Objectives and Approach chapter), we have used a gross output productivity measure due to data availability concerns. Our gross output productivity measure allows us to conduct meaningful microeconomic causality analysis (e.g., eliminating the product mix effect) that would be impossible using value added. The fact that value-added and gross output productivity measures lead to qualitatively similar results (both show a productivity growth slowdown) gives confidence that this approach is not problematic.

MGI's results are directionally similar to official estimates from the BLS and the US Bureau of Economic Analysis (BEA). The BLS, BEA, and MGI results all indicate a deceleration in the rate of labor productivity growth after 1995 (Exhibit 6). Differences between BLS, BEA, and MGI estimates can be primarily attributed to MGI's much narrower industry and product scope, which encompasses 58 percent of total industry revenue as defined by the BEA (Exhibit 7).

Though explaining the productivity slowdown was not the focus of this report, our research indicates that several non-IT factors adversely affected industry

[2] We use a BLS producer price index (PPI) for hotel guest room rental

productivity after 1995 (Exhibit 8; see Appendix 2 for a more detailed explanation of the causes of the productivity slowdown.) Three effects appear to have been most dominant:

¶ Increased turnover caused by a tight labor market for low-skilled labor increased the amount of time workers spent in training (their own and teaching others), decreasing average worker productivity.

¶ Decreased emphasis on optimal labor scheduling may have increased worker idleness.

¶ A decline in occupancy from 65.2 percent in 1995 to 63.7 percent in 1999 reduced hotels' leverage of fixed labor.

EXPLAINING THE IT PARADOX

MGI's perspective was formed primarily from in-depth discussions with over 20 experts throughout the hotel industry – from CIOs and technology VPs to property general managers. Industry participants disagreed on some specific issues – indicating variance in hoteliers' approach to IT investment and the benefits they have realized from it – but most confirmed a general lack of productivity improvement associated with most IT investment.

We first examined the nature and goals of post-1995 hotel IT investments to inform our view of the character of the expected returns on these investments. Then, we explored the firm-level, industry-level, and external causal factors that explain the apparent lack of productivity returns on hotels' IT investments.

To briefly summarize our findings, several factors contributed to the failure of hotels to realize measured labor productivity gains from their heavy investment in information technology. Many investments installed applications that remain unused or whose productivity and financial benefits remain unproven. Y2K and much merger-related investment added no new functionality. Some investment increased guest convenience in a manner that was not measured in our output quality adjustment. Finally, the investment surge occurred in an environment of record industry profitability, which may have distracted hoteliers from fully reaping the benefits of their investments.

Nature and goals of IT investments

In the late 1990s, hotels were focused on improving their top line – revenue – and made IT investments primarily to achieve this goal. The most significant IT investments were made in property management systems (PMS) and central reservations systems (CRS) . Other revenue-enhancing applications such as customer relationship management (CRM), revenue management, and Internet/Web site development were collectively significant, but largely made possible by advancements in PMS and CRS.

Information technology intersects most activities involved in selling room nights, from Internet marketing to guest checkout and billing (Exhibit 9). The main types of hotel IT investments were:

¶ **Property management systems** are the central nervous systems of hotels. In addition to performing basic front desk functions (tracking reservations and guest charges, processing check-in/out), PMS often connect all other systems at a property (yield management, guest history, point of sale at the restaurant and gift shop, activities reservations, etc.) and are the primary interface to the outside reservations network – they establish the communication link with centralized reservation centers.

¶ **Central reservation systems** support all reservations made through centralized reservations centers – the second largest distribution channel behind the property reservation department. All reservations made electronically (travel agents, Internet) and through a hotel chain 1-800 number pass through the central reservation center. Large chains often have several centralized regional reservations centers that handle reservations for the chain's properties nationwide.

¶ **Data warehouses and customer relationship management** tools store and analyze detailed customer data in order to tailor sales and marketing efforts, recognize repeat guests, and store guest preferences in order to customize future service offerings.

¶ **Revenue management systems** (RMS) determine revenue-maximizing room rates and availability. Based on historical behavior, RMS forecast future demand by detailed customer segment and restrict availability so that rooms are available for the most valuable guests – those staying the longest and willing to pay the most.

¶ The **Internet** has steadily emerged as a new channel for both marketing and booking. According to the American Hotel and Lodging Association, 90 percent of all hotels have Web sites, 84 percent have detailed photos of properties on-line, and 35 percent accept bookings on-line. In 2000, approximately 1-2 percent of all bookings were done through this channel.[3]

¶ **Regional reservations centers** (RRCs) are emerging in several dense urban areas as an alternative to property-level and centralized

[3] American Hotel and Lodging Association, "Hot Topics for 2000."

reservations.[4] Reservation calls to specific properties are routed to a regional office, where a specialist trained in reservations and knowledgeable of specific properties ("How close is it to the subway?") books the reservation, or can cross-sell to other properties if the desired one is filled up. Establishing these centers requires a significant investment in core reservations technology.

¶ **Back-office equipment** such as accounting, billing, and payroll technology can also be significant.

The desire to increase revenue was the primary business aim driving IT investment. Hotels invested heavily in PMS and CRS, a better interface between the two, and the ancillary applications that depend on them in order to achieve higher occupancy levels, higher prices, and better identification, acquisition, and retention of the most valuable guests (Exhibit 10). Other business aims such as Y2K compliance, integration and maintenance, cost reduction, and room enhancement motivated the remainder of the investment.

¶ **Revenue enhancement.** Hotels sought to increase revenue through improved reservation system efficiency, increased guest loyalty, shifting to a more profitable guest mix, and opening a new distribution channel.

- *Real-time reservations*. A more seamless PMS to CRS interface allows "single image" inventory (consistent information on room availability and pricing throughout the hotel distribution network) and "last room availability" (last room can be sold from all points in the distribution network). Previously, property managers would hold rooms from the centralized system, hoping to sell them at higher rates at the last minute. Many rooms were left unsold as a result. Truly real-time reservations, as in the airlines industry, could increase occupancy by allowing all rooms to be sold.

- *Improved guest loyalty*. Guest loyalty programs (rewards for stays), more convenient reservation/front desk processes, and tailored service offerings (using stored guest preferences) all aim to increase guest loyalty in order to generate future business. These features necessitate efficient reservation technology, fast PMS, extensive guest history databases, and a CRS-PMS interface that enables the cross-property information sharing needed to make loyalty programs work.

- *Attract/screen for high-value guests.* Hotels use CRM and revenue management in an attempt to shift their guest mix toward more profitable travelers.

[4] Only a few chains are setting up regional reservations centers in any substantial way.

- CRM allows hotels to tailor marketing efforts to very specific customer segments (or even individual guests) in order to attract the most valuable guests.
- Revenue management allows sophisticated filtering of incoming reservations by length of stay and room rate in order to maximize revenue. Based on current and forecasted bookings by segment, a RMS will determine if a reservation should be accepted. In effect, rooms are reserved for valuable, last-minute guests who are willing to pay more or stay longer. Improved PMS-CRS interfaces enable even more sophisticated central and regional revenue management – real-time access to booking information at all properties in a region provides a better view of current regional demand than one property can obtain alone.

- *Opening of a new distribution channel* (the Internet) for information and bookings could generate incremental revenue. Easier reservations, information seeking, and access to independent and boutique hotels could encourage travel. Effective Internet distribution requires investment both in a Web site and CRS or PMS to connect with it. As one executive put it, "our new CRS provides the hooks we need to connect to the Internet and our other systems."

¶ **Integration, maintenance, and Y2K.** Post-merger integration and regular maintenance of antiquated systems, combined with Y2K compliance, can explain most of the remaining IT investment.

- The late 90s saw a surge in hotel M&A (mergers and acquisitions) activity – topped by Starwood's acquisition of Sheraton (1998) and Hilton's acquisition of Promus (1999). Integrating central reservations systems and converting all properties to a similar PMS platform following such mergers is extremely difficult (and costly) due to the prevalence of proprietary legacy systems (several large chains have designed their own) and the decentralized basis on which investment decisions are made (each property decides independently). Back office technology is more easily and frequently integrated.
- Some upgrades were made because vendors were not supporting old legacy PMS.
- Y2K compliance also provided a catalyst for making PMS and back-office upgrades.

¶ **Cost reduction** was not a significant driver of IT investment during 1995-99. Continued investment in back-office technology, initial PMS implementation, on-line procurement, and labor scheduling technology occurred, but was minor in comparison to those discussed above.

Causality analysis

To simplify comparisons across "paradox" cases, MGI developed a framework for explaining IT investments that did not drive productivity enhancement. As with the framework for explaining productivity growth jumps, this "paradox" framework focuses on firm-level ("operational"), industry-level, and external factors that contributed to hotels' poor productivity returns on IT investments. The analysis that follows begins at the firm level and moves up to industry-level and external factors that helped drive the IT paradox operationally. Exhibit 11 summarizes the firm-level, industry-level, and external causal factors explored below. Please see the appendix for details on how we mapped the various IT investments against each causal factor.

Firm-level (operational) factors

The primary IT applications employed by hotels in the late 90s do not appear to have improved measured labor productivity for a number of reasons. The most significant are that: 1) IT investment installed capability that has not yielded expected benefits because it remains unused or the application remains unproven; 2) IT investments improved the reservations and front desk processes for consumers, but this convenience was not captured in our labor productivity measure; and 3) Y2K spending added no new functionality and was never meant to enhance productivity.

¶ **Unused or unproven capability.** Some applications have failed to yield productivity returns because they have yet to be fully utilized (Exhibit 12) .[5] If these applications were to be used to their fullest capacity, it is still unclear whether they would have a material impact on labor productivity. It is possible that some gains (e.g., fully utilizing PMS and CRM capability) may ultimately be competed away to the benefit of consumers or may allow hoteliers to inflate prices without commensurate improvements in service (e.g., revenue management).

- New property management systems are much more powerful than previous systems, but have not been used fully because the complementary applications and training have not yet been put into practice.

[5] Equivalent to the operational causal factor labeled "Software and hardware that did not yield expected returns" in our causal framework.

  - Extensive PMS power was required in part by the heavy computing and data storage demands of ancillary applications such as revenue management, guest history tracking, and operational analysis (for instance, identifying which menu items are most profitable). While the adoption of these ancillary applications is incomplete, the PMS capability is not fully exploited.
  - Some managers felt that "the technology has advanced further than people can handle." Most front desk workers have been trained to use character-based PMS. Upgrading to a Windows-based platform required additional training that many hoteliers have failed to provide.

- The utilization of customer relationship management tools is low and benefits (productivity and financial) remain unproven.
  - Hotels built a large infrastructure to capture and store very detailed guest history data. The most common information collected is where, when, and how long a guest stays; and what type of room, reservation channel, and amenities the guest used. Few properties actually use this information as a basis for conducting targeted marketing campaigns or personalizing the guest experience. Several executives questioned whether hotels ever would.
  - The few examples we encountered of hotels actually undertaking CRM initiatives presented a mixed picture of their utility. One executive cited the benefits of low-cost/high-response e-mail marketing that CRM enabled. Another indicated that providing customized service (e.g., remembering that a guest prefers feather pillows whenever they check into a property within the chain) is only effective locally at individual properties because information-sharing is poor and amenities offered differ greatly across properties.
  - Finally, some worried the guarantee of customization may build customer expectations beyond hoteliers' capabilities to deliver.

- Hotels have increasingly utilized revenue management as a means of increasing average room rates. Though a few companies have been using revenue management for years, widespread adoption remains low, even by properties whose national chain has invested heavily in a centralized revenue management capability. Even if RMS capability were fully utilized, the resulting price increase without commensurate service improvement does not reflect an enhancement in real labor productivity.

¶ **Unmeasured convenience to consumers.** A proportion of investment generated consumer convenience that was not captured in the quality adjustment used to construct our productivity measure.

- The typical hotel guest may have benefited from the industry's investment in information technology (Exhibit 13). It is now somewhat easier to find a hotel, make a reservation, and check into a room. This convenience can take the form of:

  – *Reduced hotel search time through reduced turndowns*. Real-time reservations (enabled by an improved PMS-CRS interface) avoid unnecessary guest turndowns, reducing the number of hotels that a guest (or his/her travel agent) must call before actually booking a room. Regional reservations centers, though in their infancy, also reduce search time by giving knowledgeable staff in dense urban areas the ability to book guests into another local property if the desired property is full.

  – *Reduced hotel search time through consistent rate quotes*. Previously, guests would often be quoted different rates for an identical room if they called the property, looked online, booked through their travel agent, or called the 1-800 number. When rates vary across channels, guests must search both across hotels *and* distribution channels to find the best rate available for the room they desire. As reservations become more real-time, these discrepancies (and associated consumer inconveniences) disappear.

  – *Ability to seek information and book rooms online*. Though Internet bookings are still a minor share (1-2 percent) of total bookings, many travelers seek information online. Consumers have much more convenient and extensive access to information to compare across chains and properties. The Internet is a particularly convenient channel for seeking information about independent hotels that lack the marketing scale of larger chains.

  – *More convenient guest check-in/-out*. New PMSs have faster processing speed, require fewer keystrokes, and faster credit card approval – all resulting in speedier guest check-in and checkout. Though staff is seldom reduced as a result, front desk professionals have more free time to service guest inquiries. Additionally, increased integration between PMS and other property-level systems (restaurant, concierge, gift shop, switchboard, etc.), enabled by PMS upgrades, has improved the accuracy of billings posted to guest accounts.

- Because service quality improvements in reservation and check-in processes were unmeasured by the BLS, price increases that may have reflected them were classified as inflation rather than output. Room and property renovations (and other physical aspects that the guest encounters) are the primary reasons for BLS quality adjustments to the PPI. Pre-stay, particularly centralized, aspects of the transaction (e.g., the convenience of finding a room and making a reservation) are not accounted for. Regardless, our interviews suggested that little of the room price increase reflected hotels charging guests for upgrades to their reservation systems.[6]

¶ **Y2K compliance** was never meant to improve productivity. Concerns about Y2K compatibility drove some investment (primarily in PMS and PC hardware and software) that did not enhance functionality.

Overall, the potential for significant technologically-driven measured productivity growth in hotels may be limited. IT intensity is low compared to other industries, and the technologies that have historically enhanced measured productivity through direct capital-labor substitution had negligible impact on post-1995 productivity. This trend is likely to continue in the future.

¶ Initial PMS installation and the automation of back-office accounting functions have had the greatest impact on productivity, but were mostly implemented by large chains (which would get the most benefit) before 1995 (Exhibit 14).

¶ The productivity impact of these technologies may have reached its limit as there are few jobs left to automate (Exhibit 15). Most employees are engaged in basic production activities such as cleaning rooms, which require little in the way of communication, collaboration, and information searching – the "interaction" activities most amenable to IT enhancement. As one property manager put it, "technology can't get you away from the basics of running the business – the basic functions like cleaning rooms just need to get done."

Before turning to the industry-level and external factors that caused the lack of productivity returns at the operational level, it is illuminating to assess the performance of IT investment against hotels' primary investment aim – increasing revenue. All hotels, regardless of IT use, were able to increase prices and revenue per room considerably from 1995 to 1999. One implication is that IT investments do not appear to have been a major differentiator of top-line financial performance between hotels.

[6] This inability to charge may have been due to the ubiquity of the systems.

- ¶ Marriott, Hilton/Promus, and Omni are regarded by many as industry leaders in the application of information technology to high-end hotels. Marriott is regarded as the industry leader in property management system innovation, the application of revenue management, and the use of regional reservations centers. Hilton, *Internet Week's* "e-business of the Year," is recognized as a leader in the use of IT for marketing, distribution, reservations, and operations. Omni is notable for its centralized PMS and RMS management systems.
- ¶ In the aggregate, these IT leaders were not able to increase their revenue per available room (RevPAR) faster than other high-end hotels in the late 1990s (Exhibit 16). They were able to maintain occupancy in the face of oversupply better than competitors, but this may have been enabled by slower-than-average room price growth, not IT.
- ¶ Only in high-occupancy markets such as New York, San Francisco, and Boston does IT appear to be a minor performance differentiator (Exhibit 17). IT leaders were able to increase occupancy and prices somewhat faster than competitors, resulting in slightly faster-than-average RevPAR growth from 1995 to 1999. It is possible that this performance differential is caused in part by IT-enabled reservation system efficiency, guest loyalty, and use of revenue management systems which are all expected to have their largest impact in high-occupancy markets.

Industry dynamics

The industry became extremely profitable in the late 1990s, following an impressive recovery from its 1990 low. Industry experts suggested that high profitability might have diverted management attention from demanding returns on IT investments and from focusing on productivity improvement (Exhibit 18). In support of this view, a recent survey of hotel executives found that only 31 percent of responding companies possessed a formal measurement system for monitoring IT investment performance.[7]

Post-1995 profit margin improvement has been achieved primarily by high price inflation. Price inflation and fixed cost reduction (due to increased reliance on equity financing) has more than compensated for increases in labor and other operating costs (Exhibit 19). In fact, 5.1 percent of the 5.3 percent annual growth rate in average room price from 1995 to 1999 was due to price increases in rooms

[7] "Hospitality 2000: The Capital," research conducted jointly by Arthur Anderson, NYU's Center for Hospitality, Tourism and Travel Administration, and HFTP.

of similar quality rather than service improvements or shifts to higher-quality rooms.[8]

External factors

The rapid overall price inflation that generated high industry profitability was driven by an economywide business cycle that created more frequent and price insensitive business and leisure travelers. In addition, aggregate prices were heavily influenced by price patterns in high occupancy markets such as New York, San Francisco, and Boston (which represent 13 percent of total US rooms and 24 percent of room revenue). Extensive price growth in these markets can explain nearly one-third of the aggregate room price growth from 1995 to 1999 (Exhibit 20).

Room supply in high-occupancy markets was slow to respond to a demand surge in the late 1990s – driving up occupancy rates by almost 3 percent – while other large markets faced oversupply. As a result, hotels in high-occupancy markets increased prices and experienced above-average profitability (Exhibit 21). Several factors may have prevented supply from responding quickly enough to match rapid demand growth in these markets.

- Hotel construction, like any other major long-term investment, is slow to respond to short-term market fluctuations. Decisions to build a hotel (particularly the large, full-service, upscale hotels found in urban areas) are informed by projections of long-term demand. Hoteliers rationally would not expand capacity immediately in response to a demand surge.
- High-occupancy markets experienced both high and rapidly rising real estate costs, fueled largely by the demand for retail and office space in a booming economy. Expensive real estate deters new hotel investment, while incumbent hotels with historic real estate agreements are sheltered from this cost – enabling price growth and profitability. Additionally, anecdotal evidence also suggests that urban land congestion and slow construction permitting processes may have also limited supply response in these markets (Exhibit 22).

A final consideration, external and unspecific to the hotel industry, is our inability to fully measure the consumer convenience generated by recent IT investments. Measuring incremental convenience improvements that are not an explicit part of a transaction (such as reservation convenience) is extremely difficult. Similar

---

[8] The aforementioned IT-enabled consumer conveniences are not captured in this analysis, but are assumed to be minor compared to other price index quality adjustments such as renovation and format shifts.

difficulties plague many other large industries; service-oriented industries such as health, social, educational, business, and personal services are the clearest examples.

OUTLOOK 2001-2005

As the economy slows and room prices fall, hotels will face more intense profit pressure and will increasingly need to justify IT investment. In response, hotels may have opportunities to take better advantage of their already installed IT capability to improve guest service – and charge for it.

However, hotels need to be conscious of the limits to their technology. Hotel work does not appear amenable to further productivity-improving automation, and revenue growth – the stated aim of IT investment – was strong for all hotels after 1995, regardless of how they used IT. Hotels should look beyond IT for sustainable sources of productivity and financial performance improvement.

APPENDICES

Appendix 1: Productivity Measurement

MGI calculates hotel labor productivity as the number of quality-equivalent room-nights sold for every hour worked by employees in the rooms operation (housekeepers, front desk personnel, bell hops, managers, etc). This output measure is derived by deflating nominal room revenues by a quality-adjusted price index (PPI) available from the US Bureau of Labor Statistics (BLS).

¶ Industry room revenue is obtained from Smith Travel Research. Smith has compiled a database including name, chain affiliation, address, number of rooms, and published room rates for approximately 40,000 US hotels with more than 20 rooms. Smith obtains actual room-nights sold and room revenue from a sample of these properties (65 percent of rooms in 1999 were sampled) and projects to the industry universe to generate industrywide estimates of rooms sold, rooms supplied, and revenue. Unfortunately, due to the low sample participation of independent hotels (18 percent by rooms), the industry room revenue estimates appear to be biased upwards.

- Compared with estimates from the US Economic Census (which we believe to be more reliable) Smith room revenue is 15 percent higher in 1987, 12 percent higher in 1992, and 11 percent higher in 1997.
- Smith estimates are likely biased due to the firm's projection method, which essentially assumes an equivalent level of performance (occupancy, average room price) between respondents and nonrespondents in a given geographic region and price tier. Price discounting (off published rack rate) by nonrespondents is also neglected during assignment to a given price tier. However, as sample participation rate has increased (from 43 percent in 1987 to 64 percent in 1997), the bias has diminished.
- Several corrections were applied to the Smith data to address this bias.
  - Smith industry revenue in 1987, 1992, and 1997 was normalized to US Census estimates.

    - The downward trend in bias was linearly interpolated between 1992 and 1997 to obtain a room revenue estimate for 1995.
    - The downward trend in bias was linearly extrapolated from 1997 at the 1992-97 rate to obtain a room revenue estimate for 1998.
  - We believe these assumptions reflect a sensible upper bound to the nominal room growth (and thus productivity growth) jump. When viewed alongside BEA and BLS estimates, both of which indicate a more rapid productivity deceleration, our estimates appear conservative.

¶ To obtain quality-equivalent room-nights, we deflated nominal room revenue by a quality-adjusted price index for guestroom rental. The index is a composite of average room price adjusted for format shifts (Smith revenue and price data by format from 1987-92, indexed using the Fisher method) and the PPI constructed by the US Bureau of Labor Statistics (1992-99). This is the same composite price index used in the BLS productivity calculations.

¶ Total hotel industry employment and weekly hours can be obtained directly from the BLS. The challenge in deriving an input measure was to separate workers engaged in the rooms operation from all other workers.

  - Industry employment by detailed occupation was obtained from the Occupational Employment Statistics (OES) division of the BLS for the years 1990, 1993, 1997, and 1998.
    - Where apparent, occupations were classified as rooms, food, or other, depending on their primary function. The largest occupations (housekeepers and wait staff) were easily classified in this manner.
    - Shared occupations such as managers and maintenance staff were allocated to rooms, food, or other based on a fraction of 1992 revenue from these services.
  - Several assumptions were applied to this employment mix data to obtain estimates of rooms operation employment for 1987 and 1995.
    - 1987 rooms operations employment was estimated by: 1) extrapolating the number of food workers per full service hotel back to 1987 from 1992 (using Economic Census data); 2) multiplying by the number of full-service hotels in 1987 to obtain hotel food employment; and 3) assuming the share in “other”

employment remains constant. This approach grounds our labor estimate in the basic industry trend away from full-service hotels.

– The occupation shift between 1993 and 1997 was linearly interpolated to obtain an estimate of 1995 rooms employment.

To minimize the number of assumptions and degree of extrapolation, we compare productivity growth from 1987-95 with 1995-98. Extending our assumptions to 1999 yields qualitatively similar results (i.e., productivity growth slowdown).

Only unlikely combinations of extreme versions of MGI's assumptions yield slightly positive estimates of real labor productivity acceleration. The set of assumptions, used to generate an upper bound for labor productivity acceleration, relied on noncontinuous behavior of the employment mix and Smith bias reduction trends. We believe it is unlikely that these extreme behaviors would occur simultaneously.

Appendix 2: Determinants of productivity slowdown

Our estimates indicate that after a moderate improvement of 0.7 percent annually from 1987 to 1995, real labor productivity in the hotel industry slowed to zero post-1995. While the bulk of our research explored why IT investments have failed to contribute to productivity growth after 1995, our analysis also uncovered several non-IT factors that may explain why productivity growth actually slowed.

¶ **Increased turnover** caused by a tight labor market for low-skilled labor appears to be the most significant negative factor. Most executives we spoke with indicated that finding and retaining employees (at all levels) was one of the greatest challenges facing hoteliers in the late 1990s.

- Entry-level hotel jobs remain one of the lowest-paid and least desirable jobs – a booming economy has attracted workers to other industries and increased intra-industry movement as employees seek higher pay. Additionally, the lack of a viable long-term career track in hotels further deters talented workers from staying. High turnover requires employees to spend more time in training (their own and with others), reducing their productivity. This occurs even if the quality of new workers remains stable.
- Reliable industrywide estimates of turnover rates do not exist for the years we are interested in. As a result, we used actual turnover data from a medium-sized hotel operator and estimates of the learning curve of front desk workers to construct a simple model of the productivity impact of changes in the turnover rate. Our interviews qualitatively supported our estimates as applicable to all workers throughout the industry
- Turnover of 100 percent annually (as is typical in the industry) reduces labor productivity to 93.8 percent of what is possible with zero turnover. A 20 percent turnover increase from 1995-98 (as was experienced by our hotel operator) reduces productivity to 92.5 percent, a 0.4 percent annual decline (Exhibit A1).

¶ **Poor labor scheduling**. Due to high profitability or inexperience, hotel management has paid less attention to productivity and labor scheduling since 1995. Small changes in the extent to which labor is adjusted downward to match actual demand can have a significant impact on labor productivity. To quantify this effect, we constructed a simple model using actual daily hotel demand data. If initially a hotel can adjust staff to within 90 percent of what is optimal given lower-than-forecast demand, productivity will be 99.4 percent of its maximum value, all else being equal. If by 1998, management inattention caused hotels to only adjust staff within 80 percent of optimal, productivity would have suffered by 0.2 percent annually (Exhibit A2). Though illustrative, this analysis implies that even a slight decrease in management attention to labor scheduling post-1995 could partially explain the productivity slowdown.

¶ **Decline in occupancy rate** from its peak in 1995 of 65.2 percent to 63.7 percent in 1998 has contributed modestly to the productivity slowdown. The 20 percent of hotel labor that is fixed – managers, maintenance, some front desk workers, etc. – cannot be reduced when occupancy declines slightly. Since these workers are putting in the same number of hours regardless of the number of guests staying on any given night, declining occupancy hurts productivity. We have estimated that occupancy patterns can explain 0.2 percent of the overall productivity slowdown since 1995 (Exhibit A3). Productivity grew 0.1 percent faster from 1987 to 1995 than it would have had occupancy remained constant, and then fell 0.1 percent annually afterwards as occupancy declined.

¶ **Compositional effects** (chains versus nonchains, luxury versus economy) appear to have had a modest to slightly positive effect on post-1995 labor productivity growth acceleration. Pre-1995 trends have more or less continued and any modest positive effects have been washed away by the negative factors described above.

- Chains (which a previous MGI study estimated to be 50 percent more productive than nonchains) have been steadily gaining market share, gradually improving industry productivity as a result (all else being equal). Due to a slight acceleration in this rate of chain affiliation (from 0.7 percent annually from 1987-95 to 1.0 percent afterwards), productivity grew 0.1 percent faster from 1995-98 than it had previously (Exhibit A4).

- There has been a continual mix shift away from expensive hotel formats – from very high end to merely upscale and from full service mid-scale to limited service mid-scale and economy. Directionally these trends have continued uninterrupted from 1987 to 1998. However, full service mid-scale hotels have experienced an *acceleration* in the rate at which they have been losing market share. Most of this loss has been to limited-service mid-scale hotels (which could be slightly more productive). All else being equal, this trend acceleration could have contributed positively to post-1995 productivity acceleration, but the effect is probably modest (Exhibit A5).

In sum, several operational factors under management control likely explain the productivity slowdown. Going forward, management should focus more attention on tracking and improving employee retention and scheduling accuracy. When combined with occupancy rate improvements resulting from a slowdown in supply growth, productivity growth should be restored as previous productivity-driving trends (e.g., chain affiliation) continue.

Appendix 3: Mapping Specific IT Investments to Causal Factors

Exhibit A6 maps the specific IT investments to each of our operational-level causal factors. As described in the main text, most applications can be characterized according to one specific causal factor. For example, all revenue management and CRM investment was attributed to the causal factor “Software and hardware that did not yield expected returns.” The major exceptions to this rule are investments in PMS and CRS. PMS upgrades have both generated unmeasured consumer convenience (through improved reservation and front desk efficiency) and installed PMS capability that has yet to be utilized. As a result, PMS investment was distributed between these two categories. Lastly, a small share of both PMS and CRS investment was initiated by Y2K compliance concerns and was not expected to yield significant returns.

CONFIDENTIAL

Hotel Industry Case Study

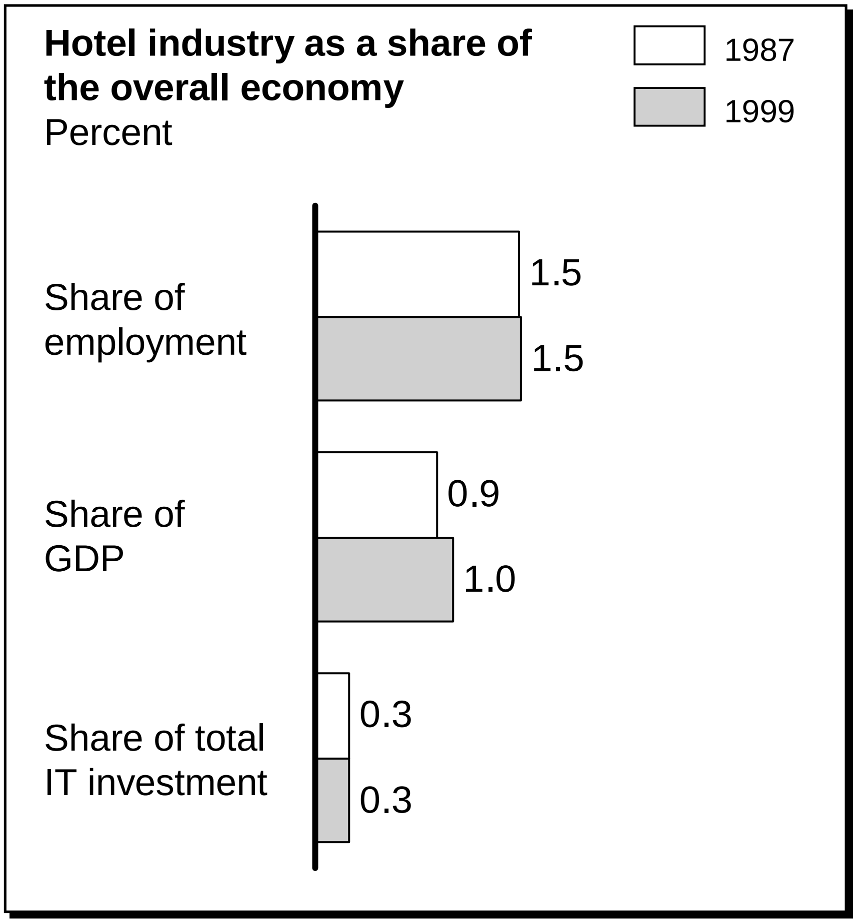
McKINSEY GLOBAL INSTITUTE

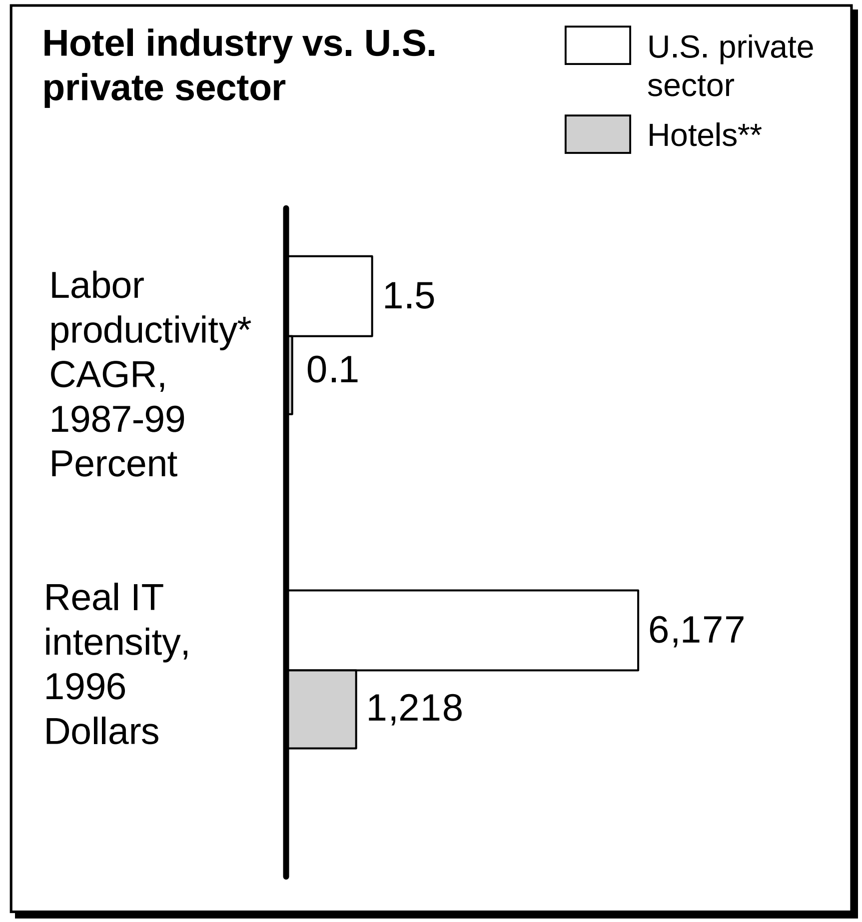
Exhibits for write-up

October 2, 2001

Exhibit 1

HOTELS ARE A SIGNIFICANT SHARE OF U.S. EMPLOYMENT, INVEST RELATIVELY LITTLE IN IT, AND HAVE HAD MINIMAL PRODUCTIVITY IMPROVEMENT





* Labor productivity is measured here as the ratio between BEA value added and persons employed in production (PEP)

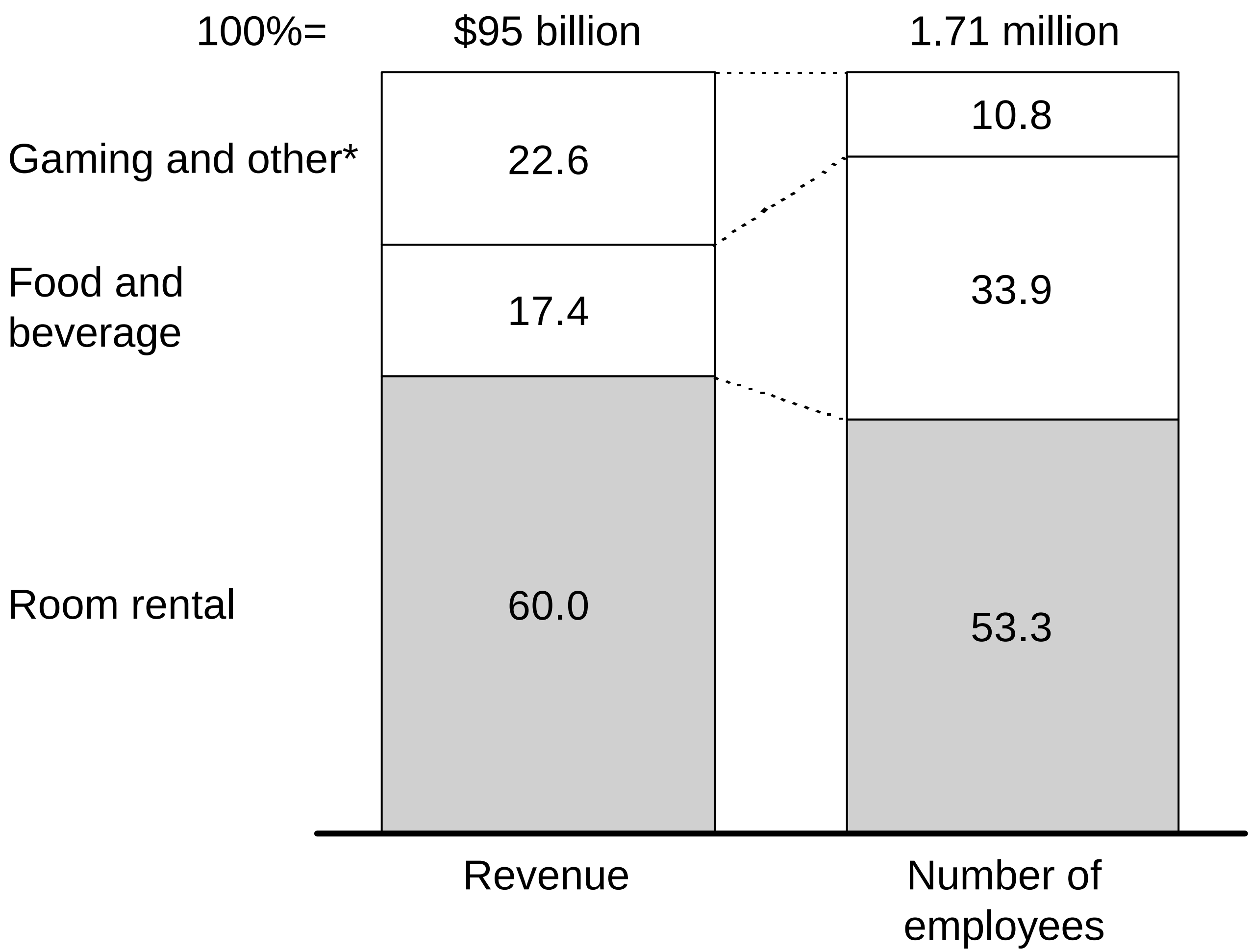
** Includes all hotel operations (rooms, food and beverage, gaming and other)

Source: BEA; MGI analysis

Exhibit 2

ROOM RENTAL IS THE LARGEST SOURCE OF REVENUE AND EMPLOYMENT IN THE HOTEL INDUSTRY

Percent, 1997



* Includes gaming (14.5%), telephone charges (1.5%), public room rental (0.8%), and other receipts (5.8%)

Source: U.S. Census Bureau; BLS; MGI analysis

Exhibit 3

THE LARGEST CHAINS REPRESENT 36% OF PROPERTIES AND 58% OF ROOMS IN FRAGMENTED DOMESTIC HOTEL INDUSTRY

Chain	**Brands**	**U.S. properties**	**U.S. rooms** Thousands	**Rooms franchised** Percent
Cendant	Days Inn, Ramada, Super 8, Howard Johnson	6,010	513	100
Choice Hotels International	Comfort Inn, Quality Inn, Econolodge, Clarion Hotels	3,108	258	100
Six Continents*	Holiday Inn, Crowne Plaza, Inter Continental	2,129	317	91
Best Western	Best Western	2,109	188	100
Marriott International	Marriott, Courtyard, Ritz-Carlton, Fairfield Inns	1,600	297	55
Hilton**	Hampton Inns, Hilton, Embassy Suites, Doubletree	1,509	263	80
Accor	Motel 6, Red Roof Inns	1,181	132	n/a
Carlson Companies	Radisson, Country Inns	463	72	94
Starwood Hotels and Resorts	Sheraton, Westin, Four Points	396	128	47
Patriot American Hospitality	Wyndham	193	42	n/a
Hyatt	Hyatt Hotels	106	54	0
All others		~33,196	~1,626	
Total		~52,000	~3,900	

* Formally Bass Hotels and Resorts

** Acquired Promus Hotel Corporation in 1999

Source: American Hotel & Lodging Association, *1999 Lodging Industry Profile and 2000 Directory of Hotel and Motel Companies*; Business Travel News; MGI analysis

Exhibit 4

PROPERTIES AND CHAINS OFTEN SHARE RESPONSIBILITIES THROUGHOUT THE HOTEL ROOM RENTAL BUSINESS SYSTEM

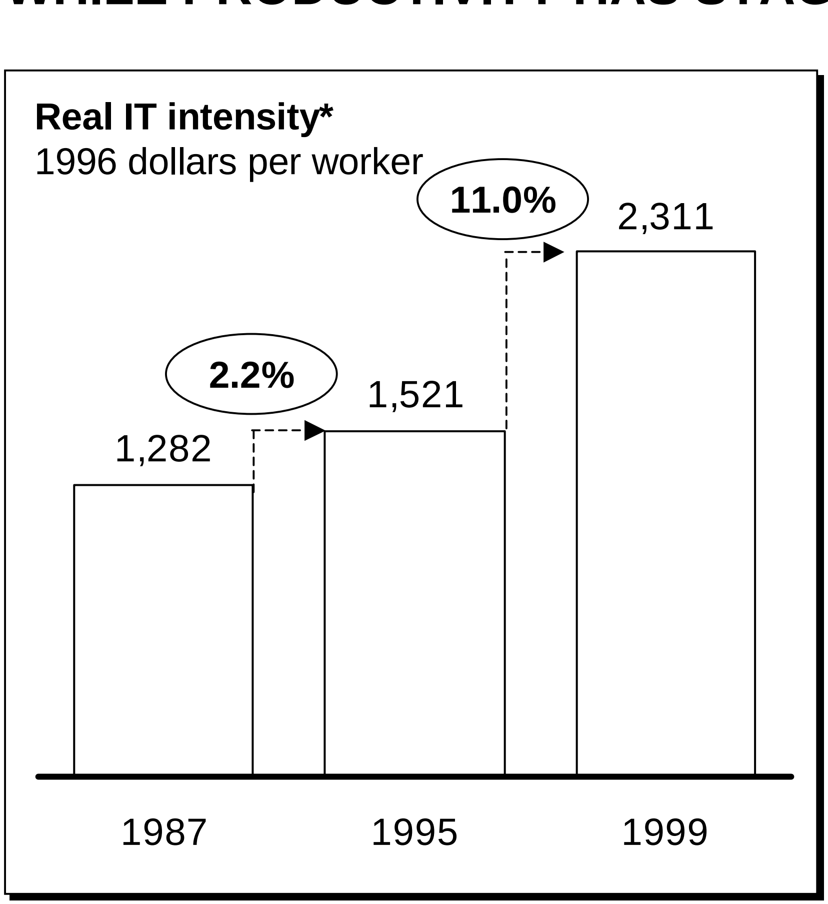
Gather and use information

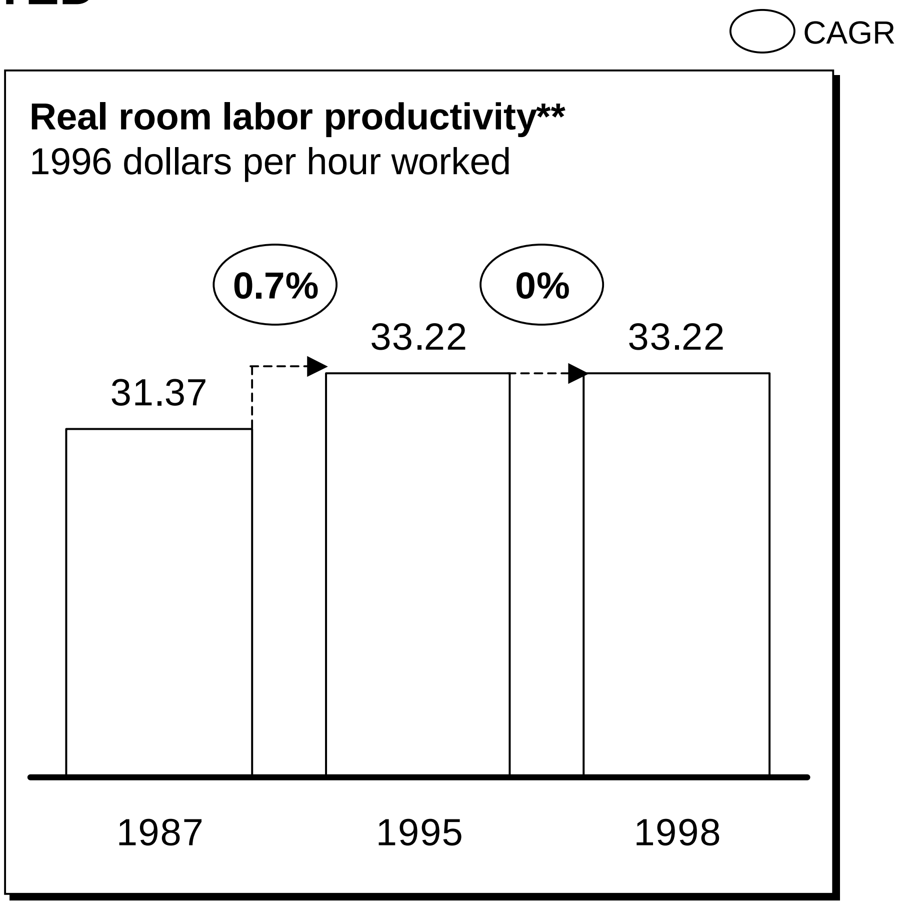
	Marketing and group sales	**Reservations:** **Rate setting**	**Reservations:** **Booking**	**Check-in**	**Provide service**	**Check-out**	**Back-office functions**
Key activities	• Develop and conduct marketing campaigns • Negotiate rates with corporate customers	• Set rates • Set availability of rates	• Reserve room • Collect guest information	• Assign room • Collect guest information	• Order supplies • Schedule workers • Clean rooms • Address guest concerns/ questions	• Collect guest charges • Settle guest account	• Process payroll • Track revenue and expenses
Respon-sibility	• Centrally by chain	• Can be done centrally, regionally, or at property	• Done centrally, regionally, at property, and by 3rd party (i.e., travel agent)	• Property	• Property	• Property	• Both at property and corporate HQ

Source: MGI analysis

Exhibit 5

AN IT PARADOX: IT PER WORKER HAS SURGED SINCE 1995, WHILE PRODUCTIVITY HAS STAGNATED





* The amount of real software, hardware, and communications equipment used per worker

** Extending productivity measure assumptions (revenue bias and occupational mix) to 1999 results in a -0.3% CAGR from 1995 to 1999

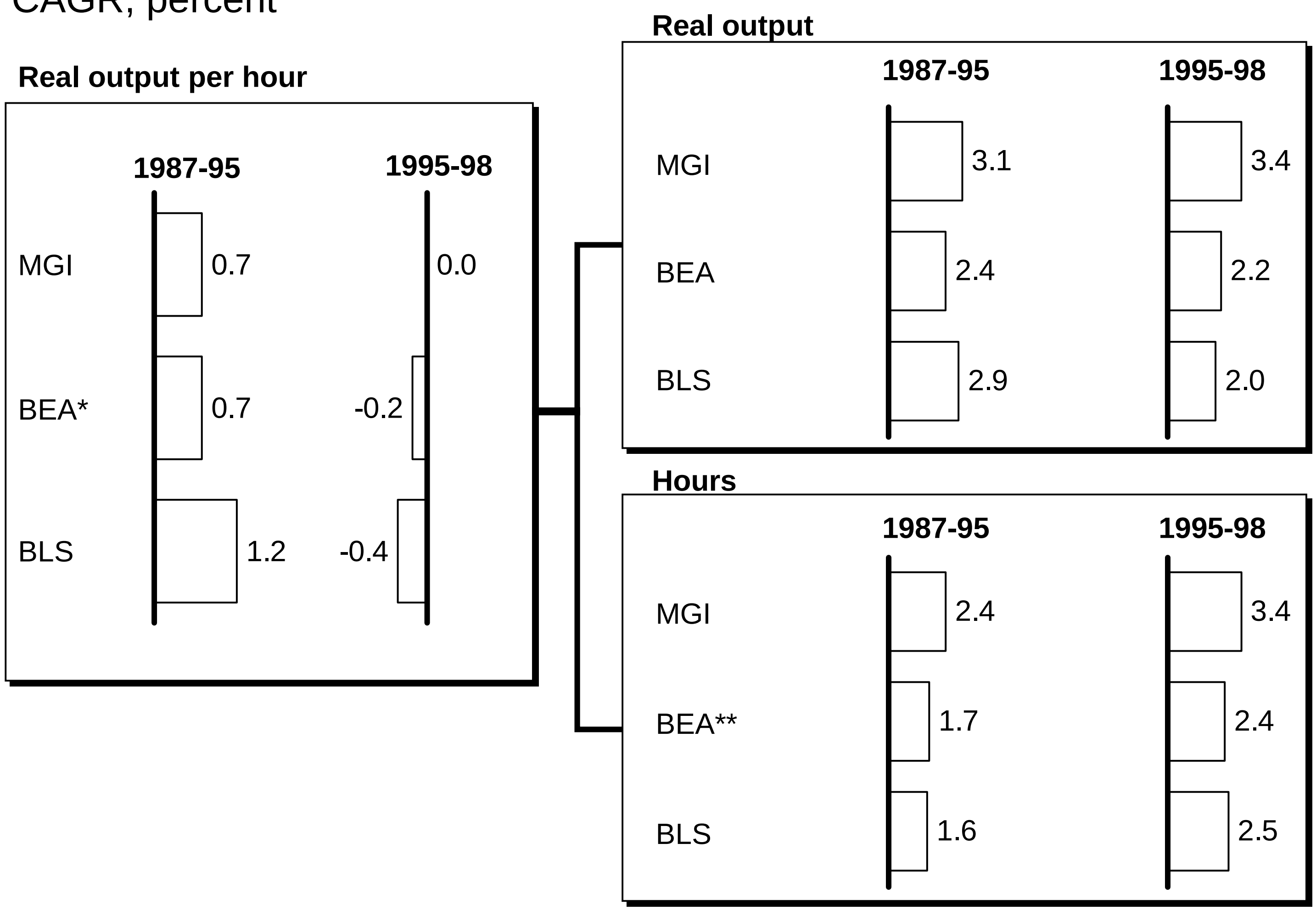
Note: IT intensity estimate scope is broader than that of the productivity estimate and includes casino and other non-food workers (e.g., drycleaners, operators) in addition to all rooms workers

Source: BEA; Smith Travel Research; BLS; MGI analysis

Exhibit 6

MGI AND GOVERNMENT ESTIMATES ALL SHOW POST-1995 PRODUCTIVITY SLOWDOWN

CAGR, percent



* BEA productivity measured as value-added per hour grew at 0.7% from 1987-95, then fell by 0.9% annually from 1995-98

** Using persons engaged in production (PEP) for hours

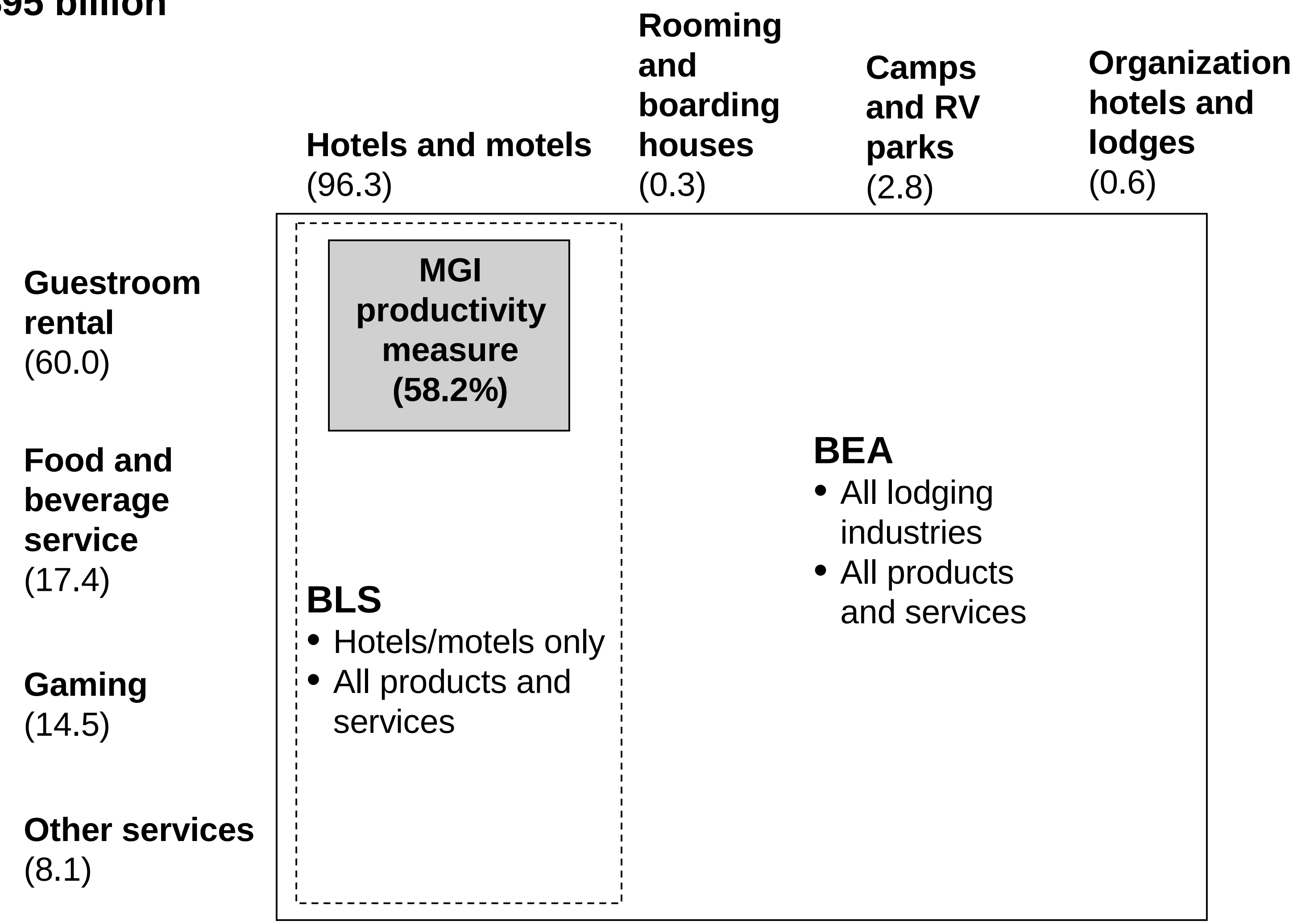
Source: Smith Travel Research; BEA; BLS; U.S. Census Bureau; MGI analysis

Exhibit 7

MGI ANALYSIS FOCUSES ON GUEST ROOM RENTAL IN HOTELS AND MOTELS, GOVERNMENT SCOPE IS BROADER

( ) Share of 1997 revenue

100% = $95 billion



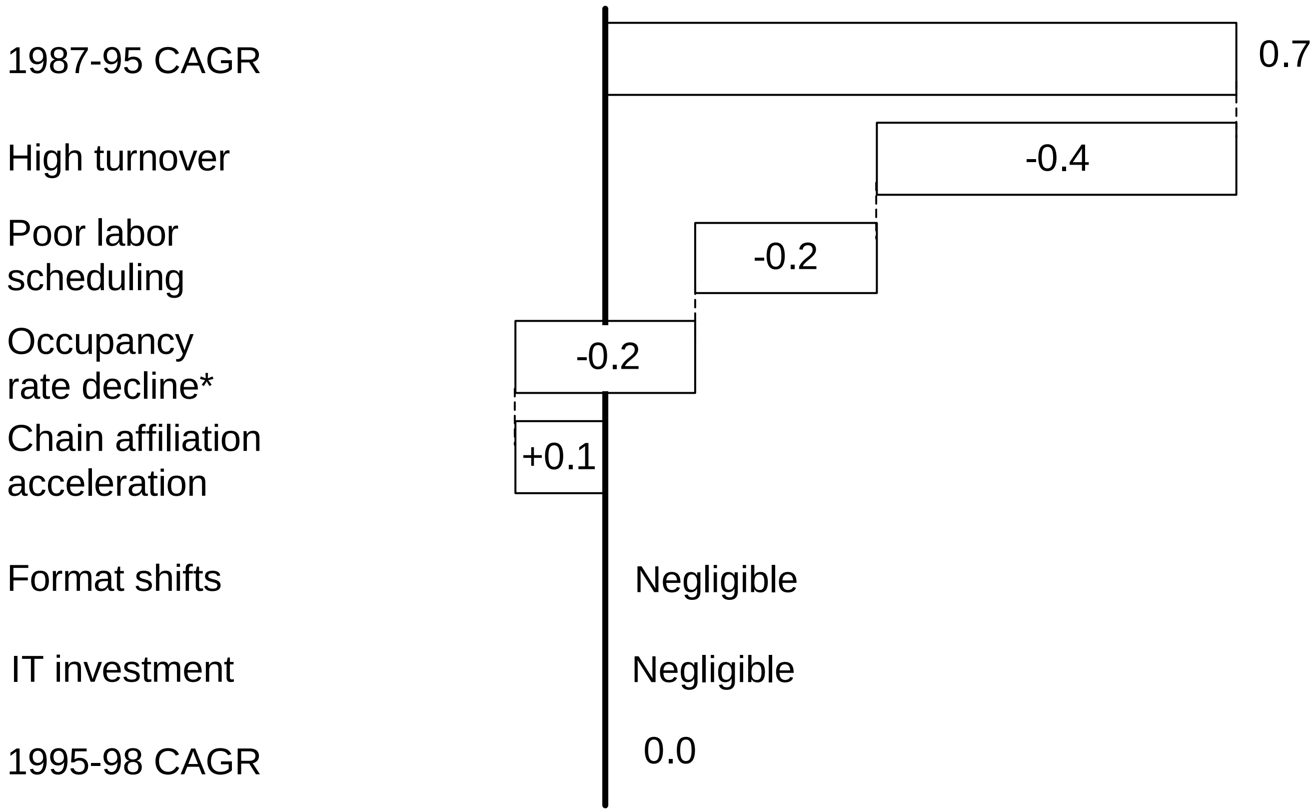
Source: BEA; U.S. Census Bureau; BLS; MGI analysis

Exhibit 8

SEVERAL NEGATIVE FACTORS CAUSED LABOR PRODUCTIVITY TO DECELERATE AFTER 1995

Real labor productivity growth

Percent

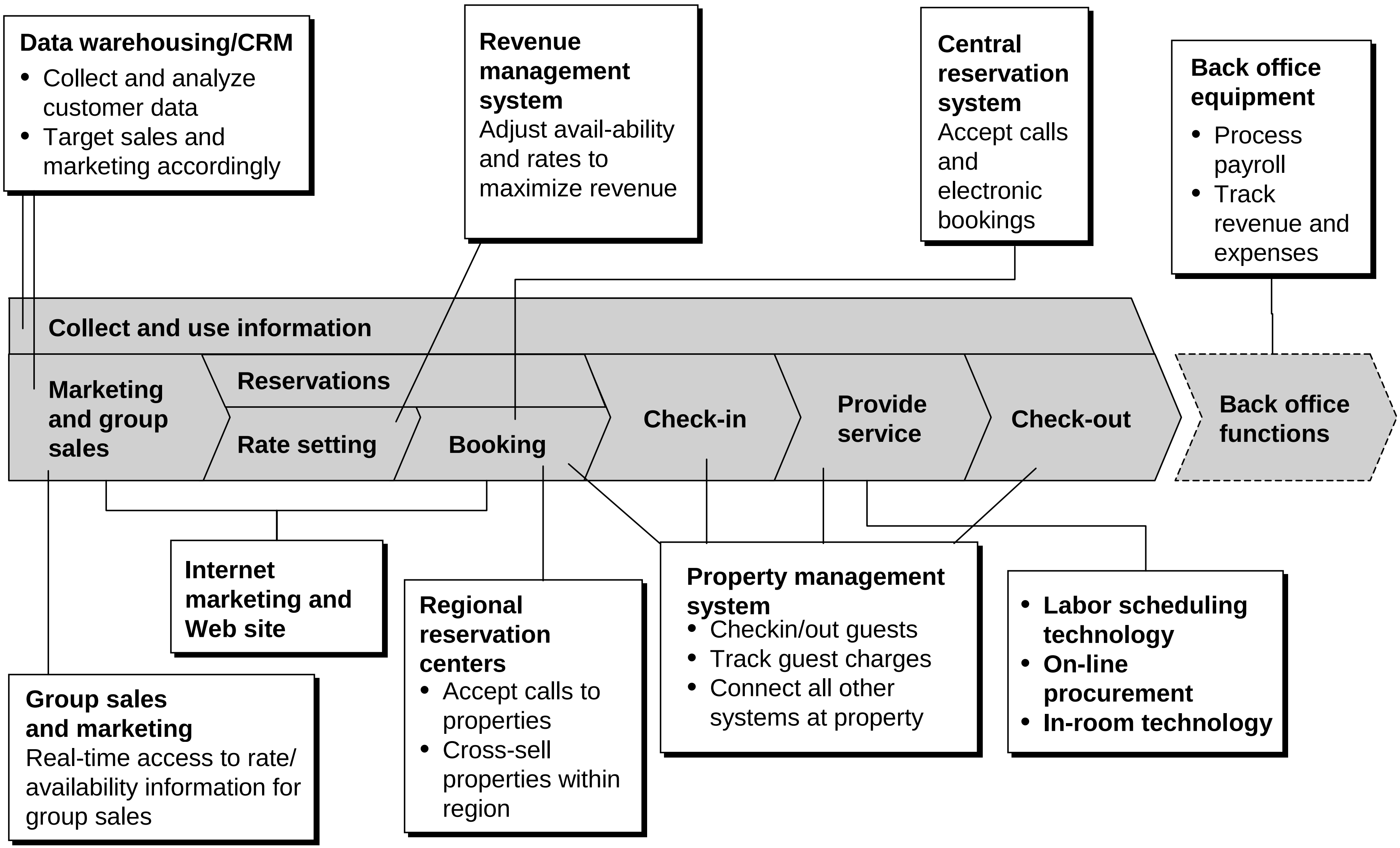


* Assumes 20% of labor is fixed

Source: MGI analysis

Exhibit 9

IT USED ACROSS THE ENTIRE HOTEL BUSINESS SYSTEM



Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 10

MOST IT INVESTMENT WAS IN PROPERTY MANAGEMENT AND CENTRAL RESERVATIONS SYSTEMS, MOTIVATED BY REVENUE ENHANCEMENT GOALS

Majority of IT investment

IT investment* 1995-99 Percent	Business motivation
55	Revenue enhancement
15	Integration and maintenance
20	Y2K
~5	Cost reduction
~5	Room enhancement
$3.8 billion	

IT investment type/application	IT investment* 1995-99 Percent
• Revenue management systems	5-10
• Data warehousing/CRM systems	5-10
• Internet marketing and Web site	5-10
• Regional reservation centers	~1
• Group sales and marketing	~0
• Property management systems (new, upgraded, integrated)	30
• Central reservation systems (new, upgraded)	30
• Non-feature-enhancing Y2K compliance (to PMS, CRS, back office)	5
• Back office IT equipment	5-10
• On-line procurement	~1
• Labor scheduling	0
• In-room technology	5
$3.8 billion	

* MGI estimates based on interviews with hotel executives and managers

Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 11

CAUSAL FRAMEWORK EXPLAINS WHY HOTEL IT INVESTMENTS DID NOT YIELD PRODUCTIVITY BENEFITS

● **Important** (>50% of investment)
◑ **Somewhat important** (10-50% of investment)
X **Not important** (<10% of investment)

	Factor	Importance	Explanation
External factors	• Capital markets/demand effects	◑	• Strong demand growth beyond hotels' supply response increased profitability
	• Product market regulation	X	
	• Y2K	◑	
	• Unmeasured consumer benefits	◑	• Customer convenience is difficult to measure when not explicitly reflected in transaction price
Industry dynamics	• Low competitive intensity	◑	• High profitability and lack of competitive intensity (especially in large urban markets) has diverted management attention from demanding sufficient returns on IT investments
	• Lower than expected demand	X	
Firm-level explanation for lack of productivity enhance-ment	• Unmeasured convenience to customers	◑	• Real-time reservations and accurate billing made possible by costly PMS/CRS upgrades, convenient internet marketing and booking capability
	• Y2K compliance	◑	• Necessary, but not designed to enhance productivity
	• Software and hardware that did not yield expected returns	◑	• Incomplete implementation of PMS upgrades; collection of data and CRM functionality not yet used; revenue management and merger integration costs do not increase productivity or service to consumer
	• Excessive/unnecessary investment	X	

Source: MGI analysis

Exhibit 12

SOME INVESTMENTS INSTALLED UNTAPPED CAPABILITIES

Property management system upgrades

- "The actual functionality of the PMS is not as important as it used to be – its use now is as a hub for connecting other systems (CRS, RM, CRM, etc.)"
- "The new PMS we installed at 6 of our properties hasn't really helped productivity because the new data mining capability hasn't begun to be used"

Benefit of PMS upgrades depend on what other modules are used – the PMS acts as an enabling platform for other applications

Data warehousing/CRM

- "We haven't begun to use our CRM capability, and I don't know if we ever will“
- “We collect a whole lot of information about our guests, but we still don’t do anything with it.”
- "Our new centralized data warehousing capability enables low-cost marketing and has generated a high response rate"

CRM applications not yet applied, but may be beneficial if utilized

Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 13

INTERVIEWS SUGGEST SOME IT INVESTMENTS INCREASED CONVENIENCE TO CONSUMERS

Central reservation system upgrades

- "Now we rarely turn away guests unless we are truly full. Our old CRS used to turn down 50% of calls because it couldn't access all rooms available at the property – the new CRS to PMS interface avoids this by allowing real-time access to rates and availability"

Property management system upgrades

- "Our new PMS can check in guests much faster and guest folio charges are so much more accurate. We haven't reduced staff, but our service has definitely improved"

Internet booking and marketing

- "Now guests have come to expect the ability to seek information and book online. Building a Web site is something you need to do just to stay in the business"

In-room technologies

- "Customers benefit from access to in-room movies and a high-speed Internet connection, but with everyone offering it, nobody is distinctive"

Regional revenue centers

- "Now we can book guests in another of our local properties if their first choice is filled up . . . they no longer need to call around"
- "Customers can now access all of our independents at the regional revenue center we set up for them"

Group sales and marketing

- "Our group sales is much more responsive – our associates can now confirm a group booking and rate while the customer is on the phone. It used to take days for us to get back with confirmation"

Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 14

INVESTMENTS WITH MEASURED PRODUCTIVITY BENEFITS WERE COMPLETED PRIOR TO 1995

Initial PMS installation	Property system integration	Back office IT
• "PMSs directly eliminate many front-office jobs; however, most large chains had implemented them by 1995" • "All of our properties had PMS by 1996"	• "An integrated PMS will reduce the amount of manual processing required to operate the system"	• "We reduced our central accounting staff by 30% – unfortunately, this is a very small part of overall work force" • "The hotel I worked in at the time eliminated their night auditors in 1995. It was a 1,300-room hotel that had previously required 3-4 people to do all the night auditing"

Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 15

FURTHER PRODUCTIVITY GAINS FROM OLDER INVESTMENTS LIMITED AS REMAINING JOBS NOT VERY AMENABLE TO AUTOMATION

Percent

	Rooms operation employment, 1998	IT investments that reduce labor	Timing of investment
Maids and housekeepers	42.3	• Labor scheduling**	• Not yet
Desk clerks	16.2	• Initial PMS installation	• Before 1995
Janitors and building cleaners	5.8		
Building maintenance	4.3		
Lodging managers and executives	4.0		
Baggage porters	2.8		
Bookkeeping and auditing clerks	1.8	• Back-office automation • Property system integration	• Before 1995 • Before 1995
All others*	22.7		

* Largest other single occupations include other service supervisors, cashiers, guards, other service workers, and clerical supervisors

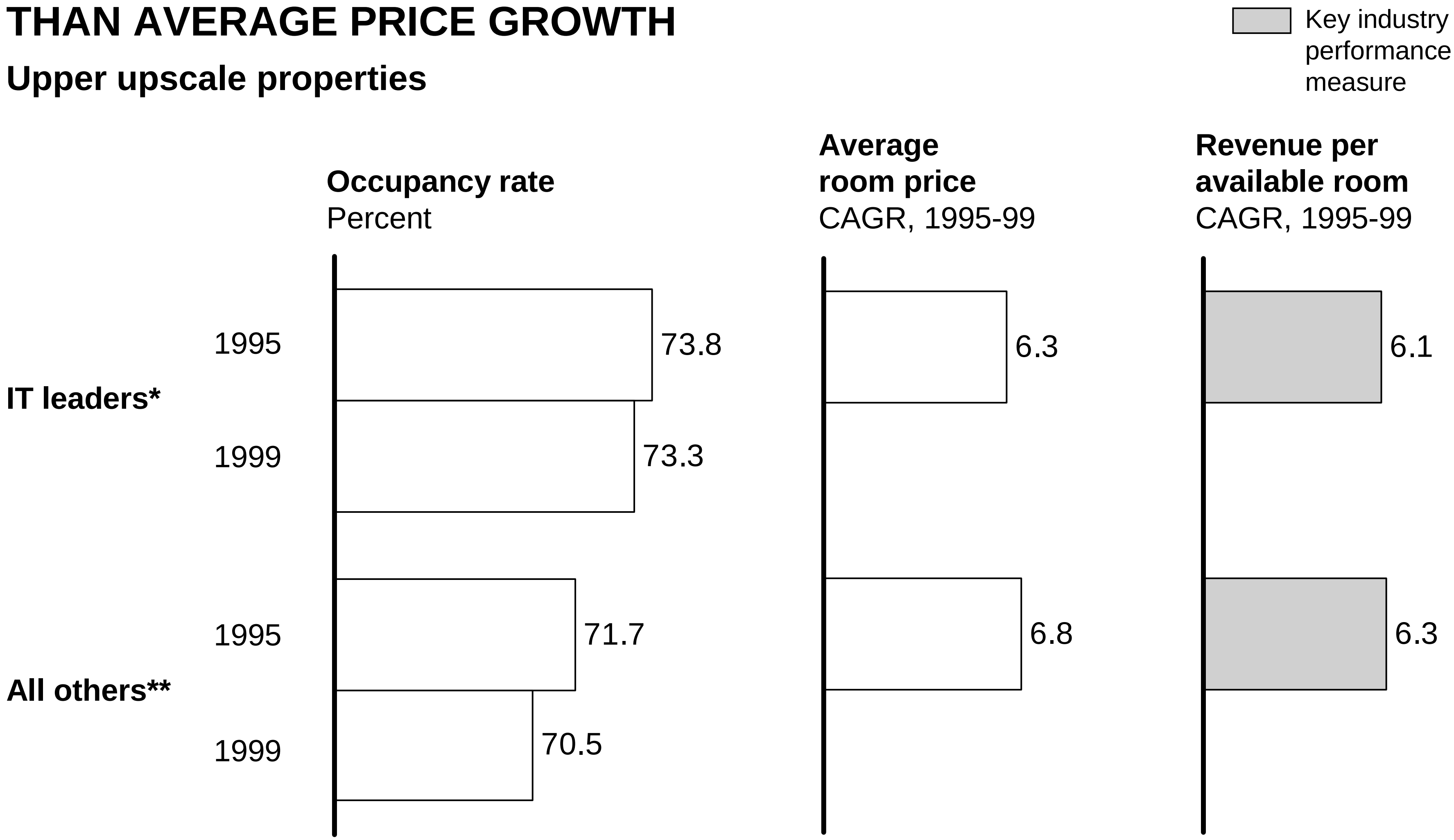
** Since labor scheduling reduces labor through process optimization, not automation, its productivity impact is more limited than other task-automating investments

Source: BLS; McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 16

NATIONALLY, IT LEADERS HAVE NOT GROWN REVENUE FASTER THAN OTHERS – STABLE OCCUPANCY LIKELY FROM SLOWER THAN AVERAGE PRICE GROWTH

Upper upscale properties



* All Marriott, Hilton/Promus, and Omni upper upscale properties

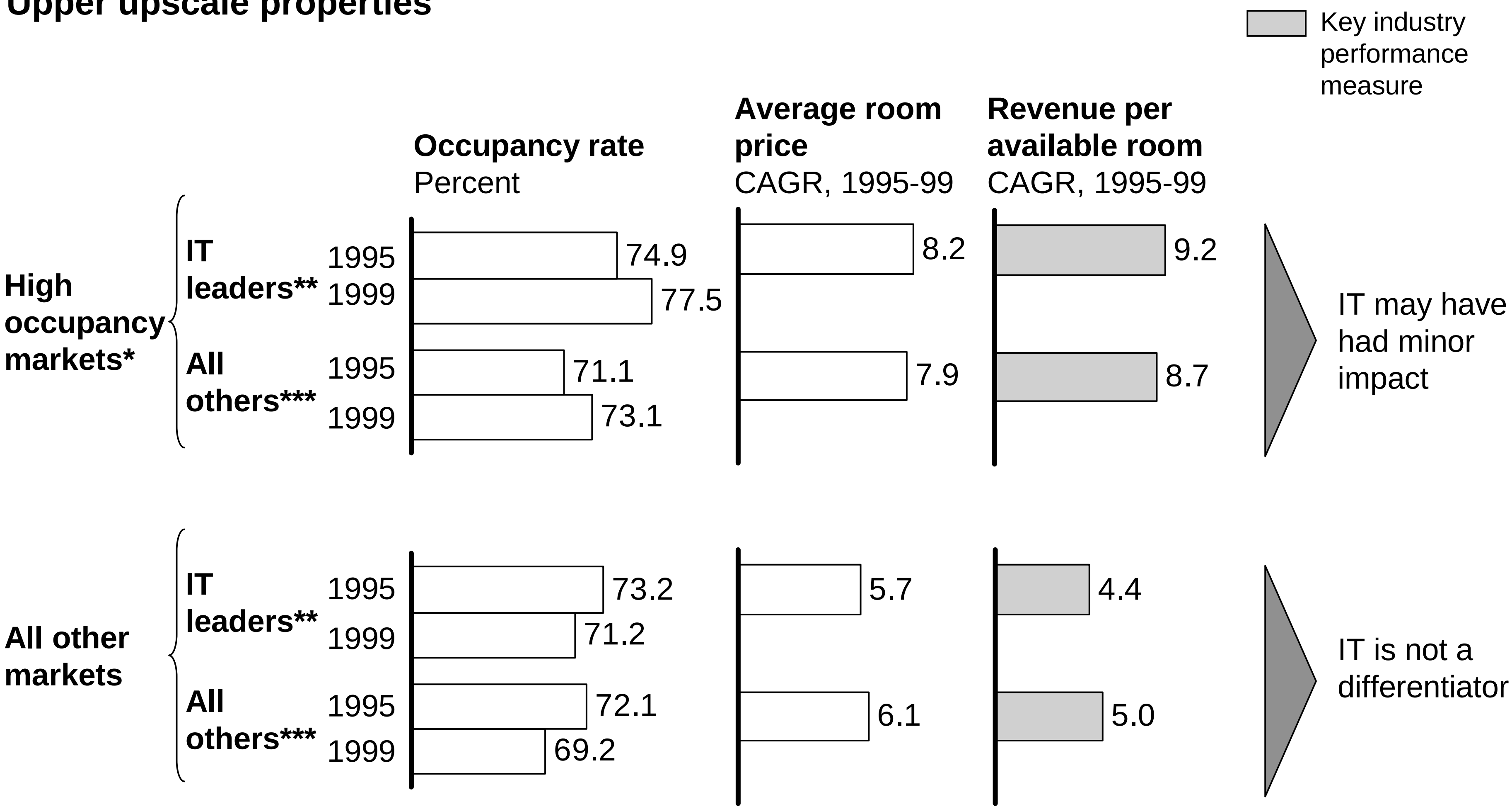
** Includes all Starwood, Hyatt, Wyndham, Fairmont, Inter-Continental, Park Plaza, Le Meridian upper upscale properties

Source: Smith Travel Research; MGI analysis

Exhibit 17

IT MAY HAVE HAD A MINOR IMPACT IN HIGH-OCCUPANCY MARKETS

Upper upscale properties



* New York, San Francisco, San Jose, Oakland, Boson, San Diego, Washington DC, Austin, Los Angeles, Baltimore, Chicago

** All Marriott, Hilton/Promus, and Omni upper upscale properties

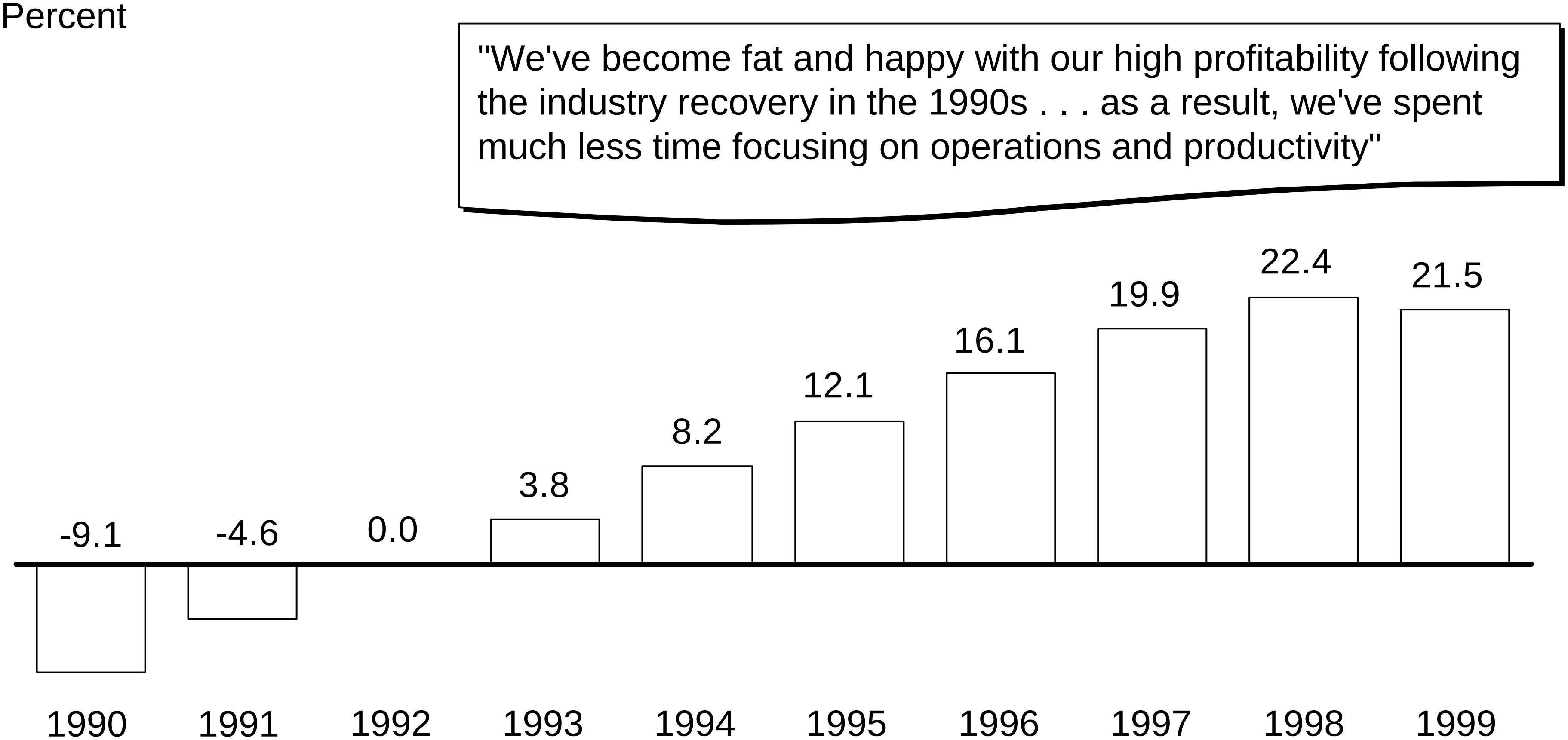
*** Includes all Starwood, Hyatt, Wyndham, Fairmont, Inter-Continental, Park Plaza, Le Meridian upper upscale properties

Source: Smith Travel Research; MGI analysis

Exhibit 18

HIGH PROFITABILITY IN THE MID-1990s MAY HAVE DIVERTED MANAGEMENT ATTENTION FROM FULLY EXPLOITING IT CAPABILITIES

Pre-tax industry profit margin*
Percent



* Gross profit margin is 2.8% higher than industry average in high-occupancy markets

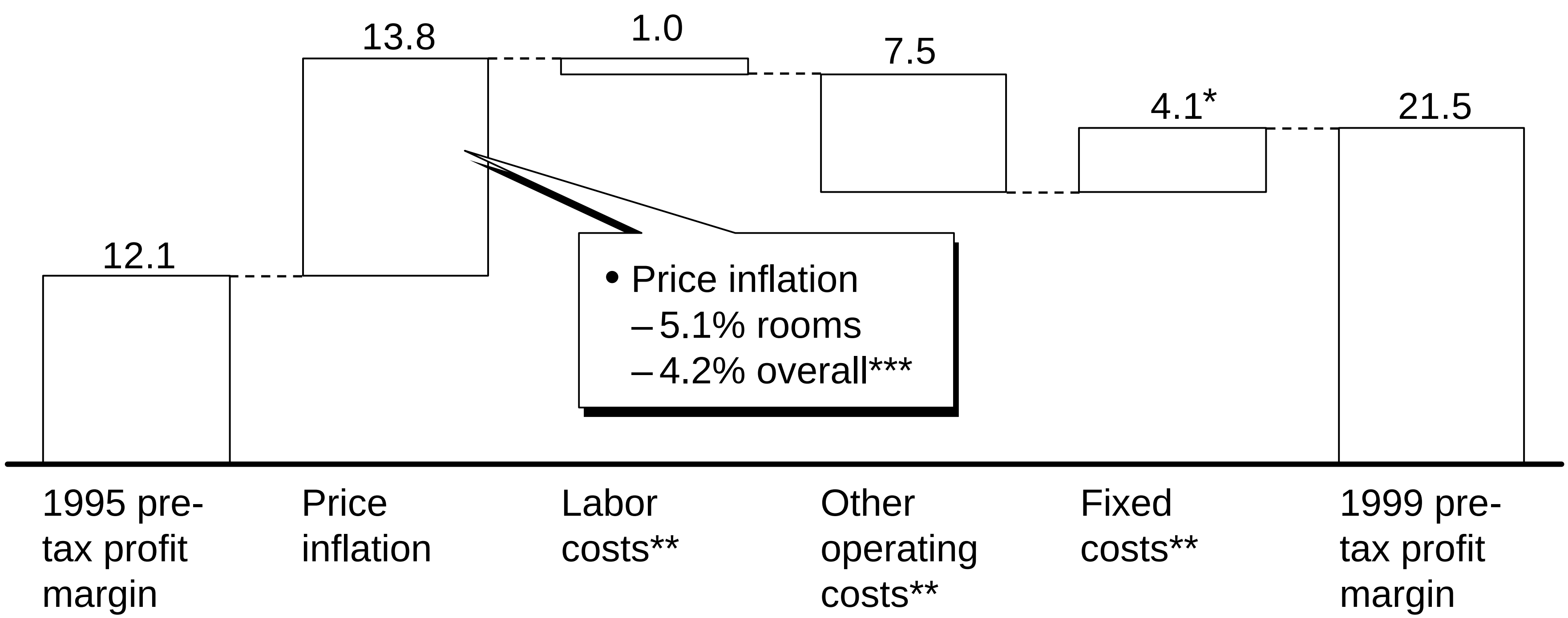
Source: Smith Travel Research; PriceWaterhouse Coopers; McKinsey interviews with hotel executives and general managers; MGI analysis

Exhibit 19

PRICE INFLATION WAS THE LARGEST CONTRIBUTOR TO PROFIT MARGIN INCREASE BETWEEN 1995 AND 1999

Pre-tax industry profit margin

Percent



* Increased reliance on equity financing (vs. debt) has reduced interest expense from 6.3% to 3.8% of nominal revenue

** Profitability change caused by changes in the ratio of nominal labor, operating, and fixed costs to real revenue

*** Includes room rental, food and beverage, gaming, telephone services, and other services

Source: Smith Travel Research; PriceWaterhouse Coopers LLP; BLS; MGI analysis

Exhibit 20

STRONG PRICE GROWTH IN HIGH-OCCUPANCY MARKETS LED TO OVERALL PRICE GROWTH SINCE 1995

Contribution to Price Growth, 1995-99

Causal factor	**CAGR** Percent	**Affected markets**	**Rationale**
Wage pressure	0.8	All markets	• CPI-adjusted wages grew at 1.6% per year from 1995-99 • Labor represents 50% of operating expense
Supply constraints	0.7	High-occupancy markets*	• Larger initial investment and financing costs prevent supply from quickly expanding in congested urban markets
Other aggre-gate factors	0.5	High-occupancy markets*	• Business cycle creating more frequent and price-insensitive business and leisure travelers • Price pressure on non-labor inputs
Other aggre-gate factors	1.0	All other markets	
1995-99 above-CPI room price growth**	3.0		

* High-occupancy business destinations, including New York, San Francisco, San Jose, Oakland, Boston, San Diego, Washington, D.C., Austin, Los Angeles, Baltimore, and Chicago, which represent 13.3% of total U.S. rooms and 24.1% of total U.S. room revenue

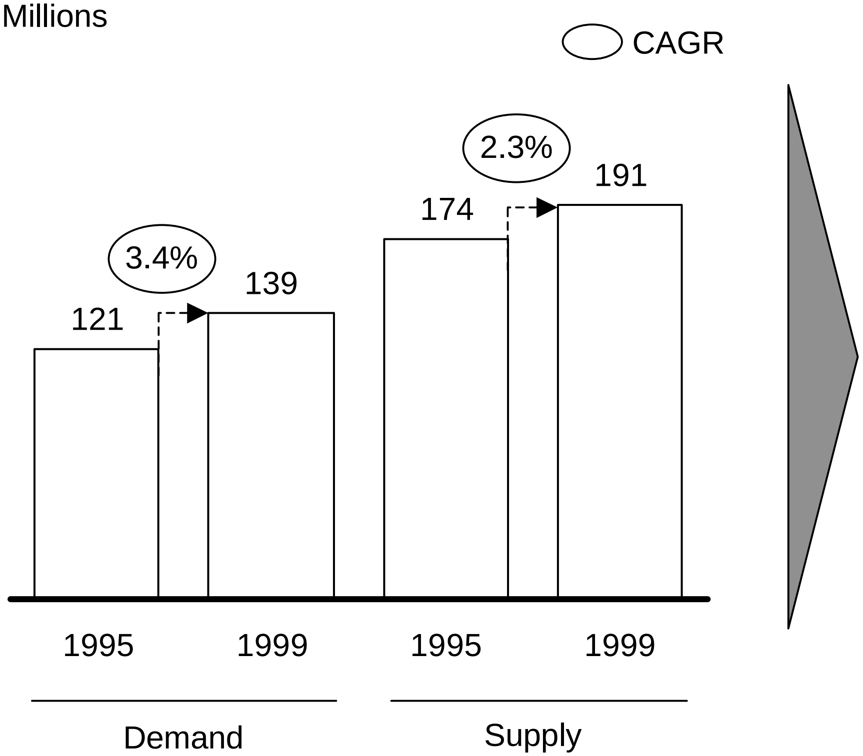
** CPI-U grew at a CAGR of 2.3% from 1995-99

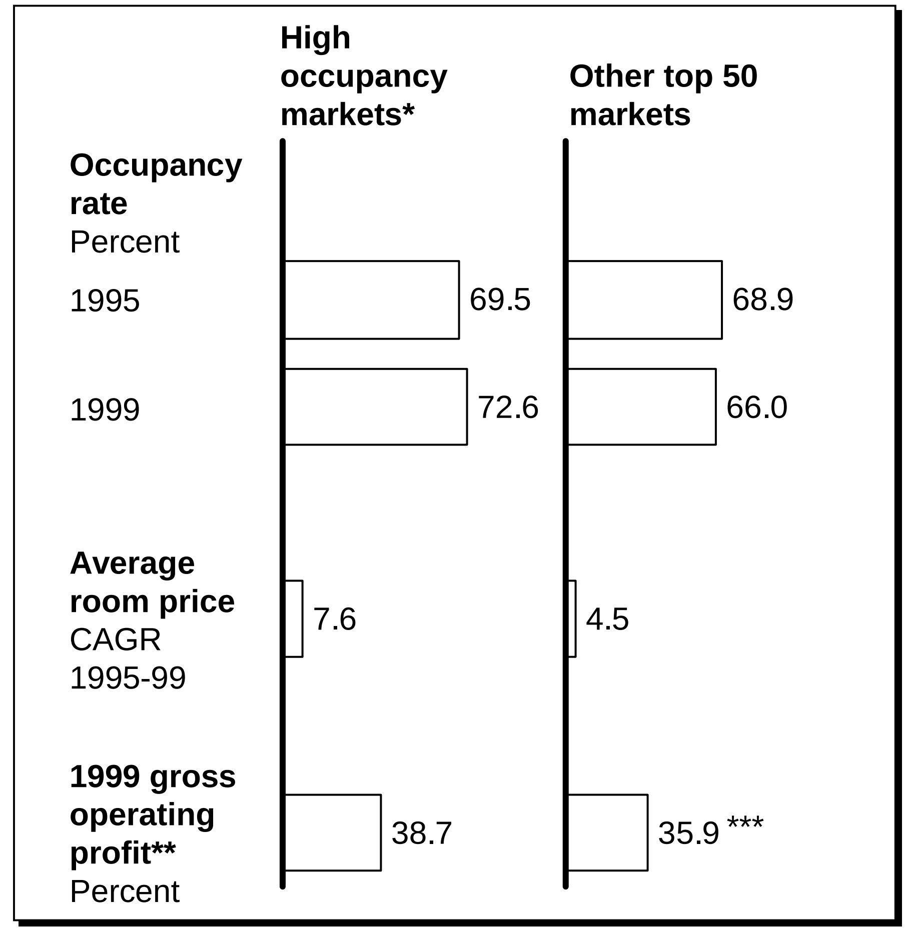
Source: Smith Travel Research; BLS; Urban Land Institute; MGI analysis

Exhibit 21

SLOW SUPPLY GROWTH ENABLED HIGH OCCUPANCY, PRICE GROWTH, AND PROFITABILITY IN CERTAIN URBAN MARKETS

Room nights in high-occupancy markets*
Millions

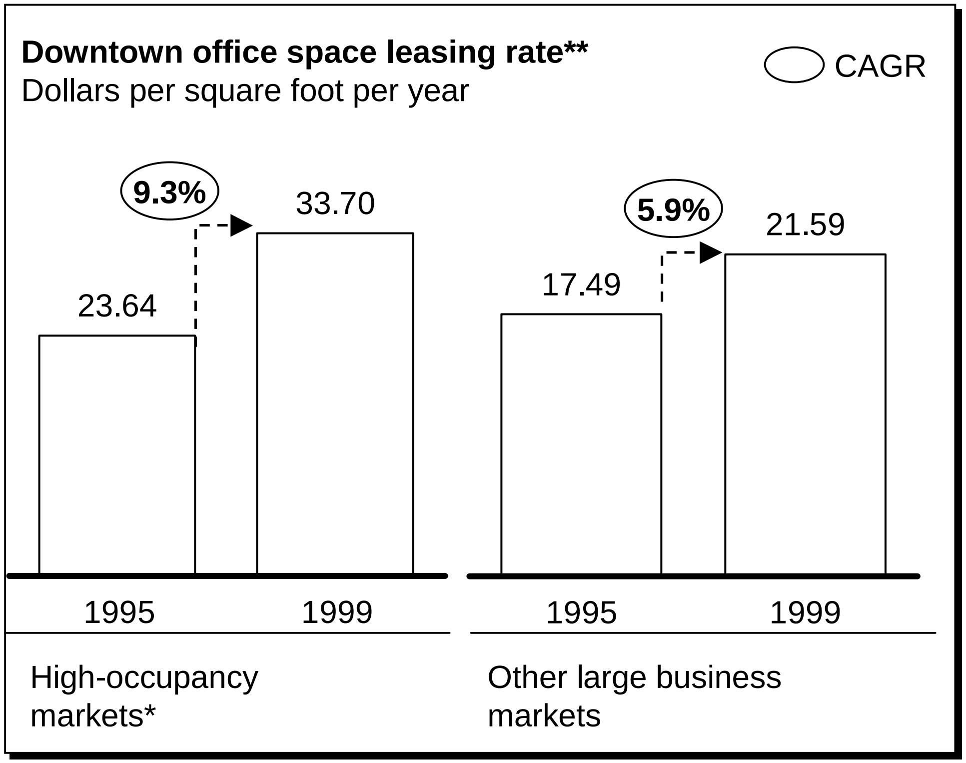




* New York, San Francisco, San Jose, Oakland, Boston, San Diego, Washington DC, Austin, Los Angeles, Baltimore, and Chicago
** Full service hotels only
*** Industry average including high-occupancy markets
Source: Smith Travel Research; MGI analysis

Exhibit 22

HIGH COSTS AND LAND CONGESTION IN HIGH-OCCUPANCY MARKETS COULD HAVE PREVENTED RAPID SUPPLY GROWTH



New York

"The current strength of residential and office markets, as well as the lack of available financing for new hotel development will continue to act as major deterrents to actual development"

San Francisco

"The public approval process is daunting . . . Marin County restricts new office construction . . . San Mateo County counts a diminishing number of excellent sites for office development"

* New York, San Francisco, San Jose, Oakland, Boston, San Diego, Washington DC, Austin, Los Angeles, Baltimore, and Chicago

** Real estate prices and growth rates are weighted by 2000 hotel room capacity

Note: Hotels compete against retail, residential, and office development for urban real estate and thus face similar real estate cost trends

Source: Urban Land Institute; Smith Travel Research; MGI analysis

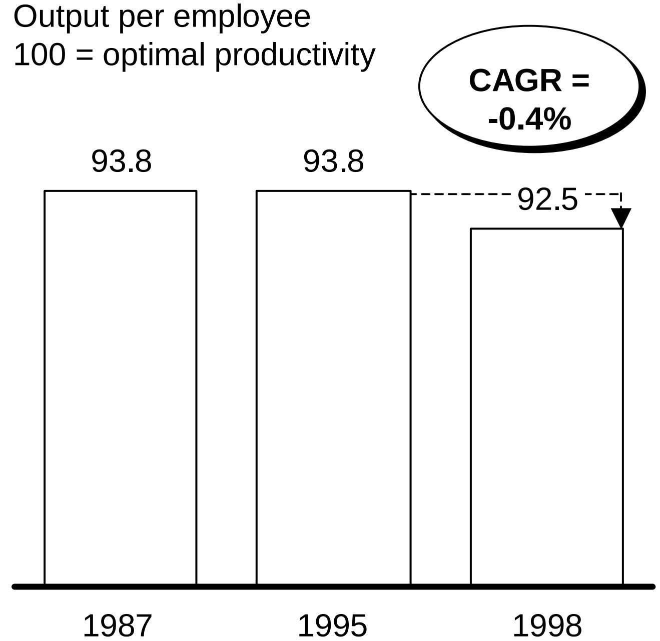
Exhibit A1

LABOR SHORTAGE HAS CONTRIBUTED SIGNIFICANTLY TO THE -0.7% PRODUCTIVITY SLOWDOWN

Key assumptions

Variable	Assumption	Source
Productivity difference between new and experienced workers	50%	Cornell study on front desk workers
Length of learning curve	3 months	Cornell study on front desk workers
Turnover rate		
1987	100%	Actual data from medium-sized hotel operator
1995	100%	
1998	120%	

Labor productivity
Output per employee
100 = optimal productivity



Note: No industry-wide turnover estimates are available; qualitative assessment from interviewees support assumptions

Source: "The Cost of Turnover," Cornell HRAQ, June 2000; Interviews; MGI analysis

Exhibit A2

DECLINE IN DEMAND FORECASTING ACCURACY MAY HAVE CONTRIBUTED TO PRODUCTIVITY SLOWDOWN

ILLUSTRATIVE

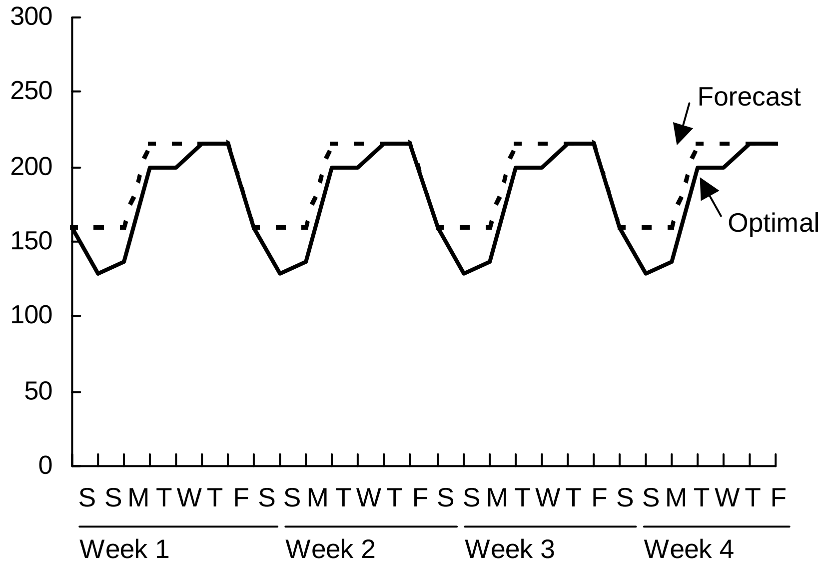
"The proliferation of franchising has **decreased the average capability of hotel industry management** because franchises are less skilled than large management companies"

– Hotel executive

"There has been an influx of people with no previous hotel management experience opening up mid-scale hotels . . . they **don't know how to forecast demand and schedule labor accurately**"

– Hotel operations expert

Daily housekeeper hours



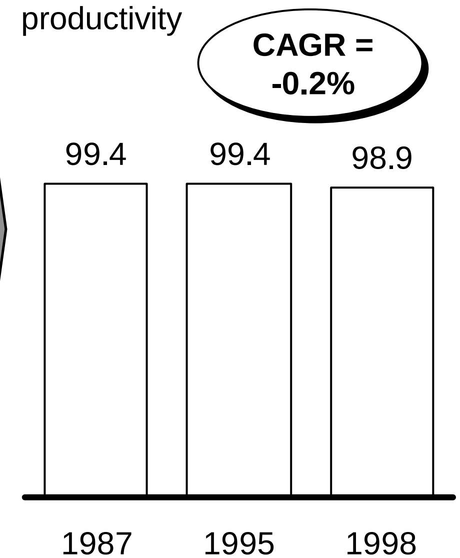
Key assumptions

- Daily rooms per housekeeper: 16
- Actual and forecast daily occupancy is constant week to week

	S	S	M	T	W	T	F
Actual	58%	64%	94%	100%	100%	100%	74%
Forecast	75%	75%	100%	100%	100%	100%	75%

- Ability to adapt schedule to lower-than-forecast demand
  - 1987: 90%, 1995: 90%, 1998: 80%

Labor productivity
Output per hour
100 = optimal productivity



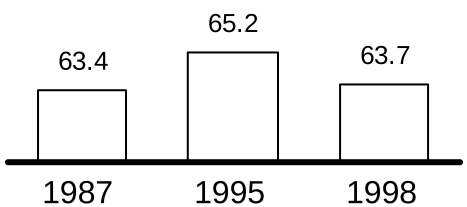
Source: McKinsey interviews with hotel executives and managers; MGI analysis

Exhibit A3

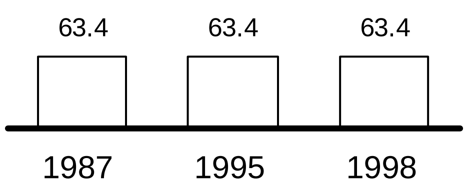
OCCUPANCY RATE DECLINE MAY HAVE REDUCED PRODUCTIVITY GROWTH BY 0.2% ANNUALLY

Occupancy rate*
Percent

Actual



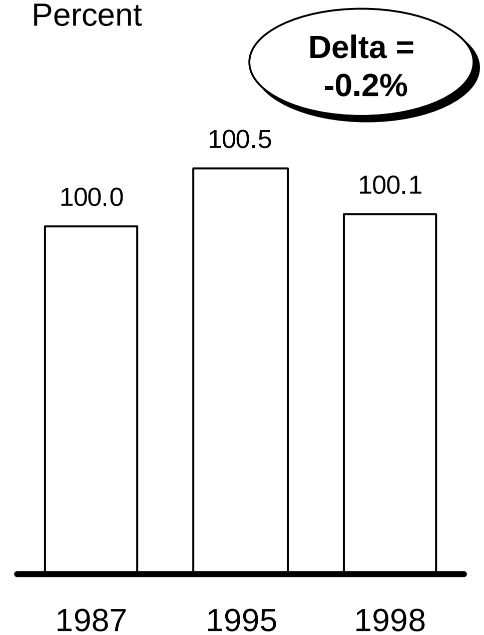
Constant



Key assumptions

- Fixed labor: 20%
- Property growth matches demand so that occupancy remains constant
- Fixed labor grows at the same rate as number of properties

Real labor productivity
Actual/constant-occupancy
Percent



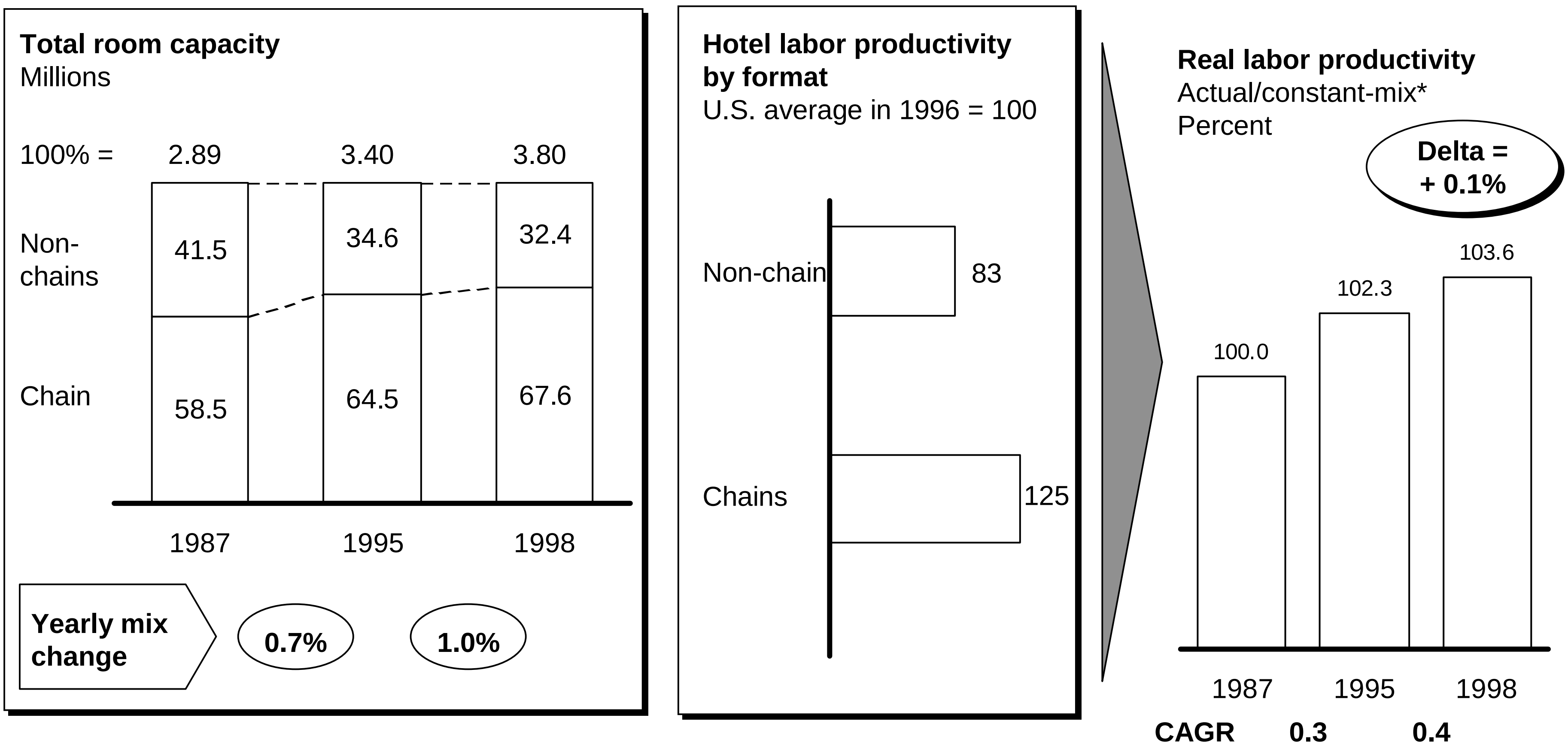
CAGR **0.1** **- 0.1**

* Total rooms sold divided by total rooms available

Source: Smith Travel Research; BLS; U.S. Census Bureau; MGI analysis

Exhibit A4

CHAIN AFFILIATION HAS SLIGHTLY ACCELERATED, CONTRIBUTING POSITIVELY TO THE DELTA



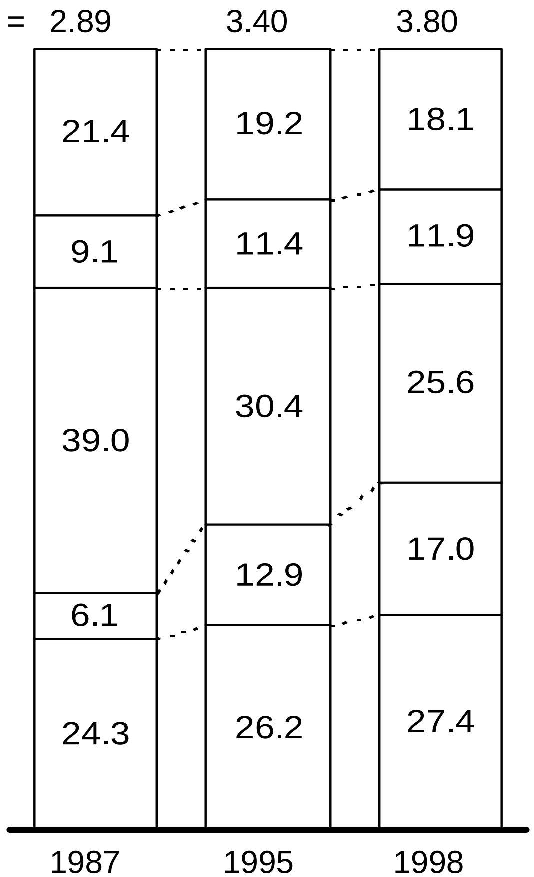
* Assuming productivity ratio between chains/nonchains remains constant over time; productivity is weighted based on room capacity shares; weighting by employment shares is preferable

Source: Smith Travel Research; MGI Russia study; MGI analysis

Exhibit A5

SLIGHT INCREASE IN THE RATE OF FORMAT DOWN-GRADING MAY HAVE POSITIVELY IMPACTED PRODUCTIVITY

Total room capacity*
Millions, percent



Yearly share change**
Percent

Format	Sample properties	1987	1995	1998	1987-95	1995-98
100% =		2.89	3.40	3.80		
Upper upscale	• Hilton, Hyatt, Marriott • International • Park Plaza, Ritz Carlton	21.4	19.2	18.1	-0.3	-0.4
Upscale	• Crowne Plaza, Hilton Inn • Doubletree, Courtyard	9.1	11.4	11.9	0.3	0.2
Midscale with F&B	• Best Western • Holiday Inn • Howard Johnson	39.0	30.4	25.6	-1.1	-1.6
Midscale without F&B	• Comfort Inn • Hampton Inn • Holiday Inn Express	6.1	12.9	17.0	0.8	1.4
Economy	• Days Inn, Motel 6 • Super 8, Howard Johnson Express	24.3	26.2	27.4	0.2	0.4

Net gain of mix shift acceleration

* Assumes independent properties are distributed evenly across formats
** The acceleration/deceleration in the rate of mix share change is similar when looking at room capacity and room demand (a biased estimate) for all formats

Source: Smith Travel Research; MGI analysis

Exhibit A6

UNMEASURED CONVENIENCE TO CUSTOMERS REPRESENTS THE LARGEST SHARE OF IT INVESTMENT

Percent

	Share of investment attributed to casual factor*				
IT investment	**Unmeasured convenience to customers**	**Y2K compliance**	**Software/ hardware did not yield returns**	**Excessive investment**	**Total***
Revenue management systems	0	0	5-10	0	**5-10**
Data warehousing/CRM systems	0	0	5-10	0	**5-10**
Regional reservation centers	~1	0	0	0	**~1**
Group sales and marketing	0	0	0	0	**~0**
Internet marketing and Web site	5-10	0	0	0	**5-10**
Property management systems (new, upgraded, integrated)	15	5	10	0	**30**
Central reservation systems (new, upgraded)	15	5	10	0	**30**
Non-feature-enhancing Y2K compliance (to PMS, CRS, back office)	0	5	0	0	**5**
Back office IT equipment	0	5	0	0	**5-10**
Labor scheduling	0	0	0	0	**0**
On-line procurement	0	0	~1	0	**~1**
In-room technology	5	0	0	0	**5**
Total	**40-45**	**20**	**30-40**	**0**	**100**
Importance	◑	◑	◑	○	

* MGI estimates based on interviews with hotel executives and managers

Source: McKinsey interviews with hotel executives and general managers; MGI analysis

Productivity Growth and Information Technology

Two discontinuities occurred in the United States from 1995-2000. Productivity growth, which had been averaging 1.4 percent per year from 1972-1995, jumped to 2.5 percent (Exhibit 1). At the same time, the rate of nominal business investment in Information Technology (IT) surged to 17 percent per year, from its 1987-1995 rate of 9 percent. The simultaneous occurrence of these two events was particularly interesting because until 1995, productivity growth had been flat while IT spending had been on the increase. Robert Solow (MIT Nobel laureate and chair of Academic Advisory Committee for this study) summed up the situation in 1987 when he quipped that, "You can see the computer age everywhere but in the productivity statistics." The simultaneous jumps in productivity growth and IT intensity had prompted many to speculate that perhaps the "Solow Paradox" had now been resolved. But perhaps more fundamental was the speculation, and indeed, exuberance that the US economy had now entered a new era, the *new economy*, characterized by higher productivity growth driven by IT.

In September 2000, the McKinsey Global Institute (MGI) launched a year-long effort focused around two key questions: First, what had caused the productivity growth jump and second, what had been IT's role in the productivity jump. Our research shows that nearly all of the post-1995 productivity growth jump can be explained by the performance of just six economic sectors: retail, wholesale, securities, telecom, semiconductors, and computer manufacturing. The other 70 percent of the economy contributed a mix of small productivity gains and losses that offset each other (Exhibit 2). The overall findings of our research are summarized in the attached Executive Summary, and the details can be found in the extensive research report, "US Productivity Growth, 1995-2000." (**http://www.mckinsey.com/knowledge/mgi/feature)**

In summary, IT's role in the overall productivity jump, as measured, came in two principal forms:

¶ Three IT producing and providing sectors - semiconductors, computer manufacturing, and telecom (mobile and long distance), while only 5 percent of GDP and 4 percent of employment, contributed 29 percent of the economy-wide net productivity jump. Indeed, of the six sectors, the two that experienced the steepest productivity growth jumps were semiconductors and computer manufacturing.

¶ The use of IT was one of several key factors at work in the six sectors that account for almost all of the net jump in productivity growth. Innovation (including, but not limited to, technology) and competition, and to a lesser extent cyclical demand factors, were the most important factors.

It is important to note that some benefits of IT such as user convenience created by the Internet was not fully captured by productivity measures. If these benefits were fully captured in government output measures, output and therefore productivity measures would be higher. However, in our case studies we also examined physical output measures that avoid this problem. Hence we do not believe these discrepancies would change our conclusions.

The story around the use of IT and productivity is complicated by two additional findings from our work: First, during a period where IT spending intensified, we found that the six sectors only accounted for 38 percent of the aggregate IT intensity jump. The majority, 62 percent, of the IT intensity jump, was in the other 53 sectors that as a group did not contribute materially to the net jump in productivity growth – indeed some of these sectors experienced decelerating productivity growth (Exhibit 3). Second, attempts to establish a direct and simple correlation between jumps in productivity and IT intensity yielded statistically insignificant results, even when lagged (Exhibit 4). These findings suggest that the relationship between IT use and productivity is clearly not a direct or, indeed, a simple one.

Therefore, in order to get deeper insights into the drivers of productivity and the role of IT, we studied the six "jumping" sectors, as well as three "paradox" sectors that invested heavily in IT but failed to boost productivity (hotels, retail banking, and long distance data telephony). The existence of so many "paradox" sectors indicate that IT alone is not a "silver bullet" that can drive productivity growth. Moreover, in the "jumping" sectors, our findings suggest that it is only when IT enables managerial innovations, facilitates the reorganization of functions and tasks into more productive approaches, and is applied in labor intensive activities, that it plays a major role in driving productivity.

There are important implications for the IT industry based on findings from our work: First, IT spending boom was largely driven by a "perfect storm" of demand drivers that resulted in spending that was roughly 28 percent above 1987-95 trend. This has potential implications for likely near-term growth of the sector. Second, a return to higher growth rates for IT crucially depends on two types of innovation: new uses that transform products or processes; and new invention that drives another perfect storm of infrastructure innovation.

The remainder of this paper is in four sections: first, the contributions of the IT producing and providing sectors to the overall productivity jump; second, the role of IT use in the productivity of sectors; third, the nature of the IT investment boom; and fourth, implications for the IT sector.

IT PRODUCING AND PROVIDING SECTORS

Of the 6 sectors that contributed virtually all of the net jump in productivity growth, three were IT producing and providing sectors – semiconductors, computer manufacturing and telecommunications. Together these three sectors contributed 29 percent to the net jump in productivity, despite making up only 5 percent of the economy. This contribution occurred simply through the production and provision of goods (chips and PCs) and services (voice transmission).

Productivity growth in the semiconductor industry accelerated from 43 percent to 66 percent because the performance of the average chip sold accelerated (Exhibit 5). This was due to Intel shortening the time between new product introductions and more rapidly improving the performance of each new chip. Both were done largely in response to competitive pressure.

In computer manufacturing, nearly all of the productivity acceleration was due to innovations outside the sector itself (Exhibit 6). Technological improvements in microprocessors and other components (memory, storage devices), as well as the integration of new components (CD ROMs, DVDs), caused an acceleration in the measured value of computers being assembled. At the same time, a convergence of unusual factors (see the IT Investment Boom, below) caused a surge in demand for more powerful personal computers that explained a portion of the productivity acceleration in both computer manufacturing and semiconductors.

The story in telecom revolved around regulatory changes and technical innovations. In particular, the productivity jumps occurred in mobile and in long distance telephony. The licensing of new spectrum heightened competition and reduced supply constraints. Both effects facilitated rapid increases in mobile telecom usage. At the same time, digital switches and cellular equipment provided new standards that facilitated price declines by allowing better use of the spectrum.

USE OF IT AND PRODUCTIVITY

What became of the products and services generated by these industries? The application of IT was certainly important. It played an enabling role in several sectors (e.g., warehouse automation in wholesale; tailored EDI systems at Wal-Mart and its imitators in retail general merchandising) and a more central role in others (i.e., back office automation and, to a lesser degree, the exploitation of the Internet in the securities sector). Generally speaking, the most successful applications we found were "vertical," industry-specific ones, with direct impact on the core activities of the industry. Interestingly, many IT solutions that were readily available prior to 1995 were critical contributors to the jump. To the extent that a new, higher productivity economy came into being after 1995, it was not due to the application of contemporaneous innovations made by the IT producing industries.

However, the diversity of operational factors that caused the 1995-99 productivity growth jump is striking. As noteworthy is the prominence of factors unrelated to IT (e.g., improved organization of functions and tasks in wholesale distribution centers, retail general merchandising, and long distance telecom; the business decision by Intel to shorten product life cycles; and the ability of computer assemblers, retailers, and wholesalers to pass through higher value computers and goods with no attendant increase in labor). From an operational perspective, the 1995 productivity growth jump was far more than an IT story. Many other factors were necessary and, in some cases, the application of IT simply did not make a meaningful contribution to the productivity growth jump. Surprisingly enough, this was particularly the case in one of the IT producing industries, computer assembly. The acceleration in the growth of the performance of computers explains 90 percent of the jump in productivity. High growth rates in units produced per employee were driven mainly by architectural simplification rather than by IT enabled supply chain management or build-to-order.

The remaining 69 percent of the economy, in which 62 percent of the surge in IT intensity took place, made a series of small positive and negative contributions to the productivity acceleration (Exhibits 2 and 3). In total, the rest of the economy contributed only 1 percent of the net productivity acceleration. Even leaving out the offsetting negative sectors, the positive sectors contributed just 26 percent to the gross, economy-wide productivity acceleration (compared with 74 percent for the key six sectors). Total factor productivity (TFP) growth, which represents improvements in labor productivity attributable neither to increases in capital investment, nor to improvements in the labor supply, was negative (at -0.3 percent per year) during 1995-99 for the 69 percent of the economy outside of the six jumping sectors (as opposed to +0.4 percent per year for 1987-95). This means that outside of the six "jumping" sectors, IT capital generated productivity returns similar, at best, to other forms of capital. TFP growth rates for the six jumping sectors were 2.2 percent per year for 1987-95 and 7.8 percent per year for 1995-99. The high TFP growth rates here are attributable to a diverse set of drivers including but not limited to IT.

MGI's review of "paradox" sectors was revealing. The reasons for surging IT spending not causing increases in productivity growth ranged from spending on applications that delivered small, unmeasured productivity benefits in the hotel industry and, to a lesser degree, the retail banking industry; to spending driven by one-off factors such as Y2K compliance; to spending that has simply not delivered as hoped, either because the benefits are still to come, or because it may have been excessive. Our case study interviews with executives and analyses at the firm level confirmed that CRM and revenue management initiatives in the banking and hotel industries, for example, have not yet yielded the expected benefits.

THE IT INVESTMENT BOOM

Although there is little evidence that IT was the preponderant cause of the US' productivity growth acceleration, an astonishing boom in IT investment did take place from 1995 to 2000. What caused this boom, and why has it ended so suddenly?

IT investment by US businesses accelerated dramatically above the long-term trend after 1995, reaching close to $3,000 per employee per year by 1999 (Exhibit 7). A total of $1.24 trillion dollars was invested in new IT between 1995 and 1999. Nearly 30 percent of this IT investment was driven by unusual factors (Y2K, the emergence of the Internet, the initial buildup of corporate networking infrastructure, and rapid PC upgrade cycles) that led to higher penetration and a shortening of replacement cycles (Exhibit 8). As a result, real IT capital stock, which takes into account performance improvements, nearly doubled between 1995 and 1999 (Exhibit 9). In other words, US businesses doubled their total IT capabilities in just four years. Absent the extraordinary factors, IT investment would have been more similar to the long-term trend.

An average employee is now empowered with over $8,000 worth of IT capital, more than half of which is in software (Exhibit 10). By 2000, business PC penetration (measured as the total number of units of PCs deployed versus total number of employees) stood at 56 percent after increasing at a rate of almost seven percentage points per year during the late-1990s. Business PC penetration is quickly approaching its likely upper threshold of ~70 percent (Exhibit 11).

With Y2K over, Internet infrastructure in place, companies and consumers taking a more cautious approach to PC upgrades, and no compelling new broadly applicable software applications, it is little wonder that by late 2000 PC investments were showing signs of a slowdown. By the second quarter of 2001, IT investments per employee had dropped nearly 10 percent from the previous year (Exhibit 12). For the first time in their short history, US computer manufacturers are facing the prospects of negative unit growth. The IT industry is sailing into uncharted waters.

IMPLICATIONS FOR THE FUTURE OF THE IT INDUSTRIES

The goal of our study was to generate insights about the relationship between IT and the productivity growth jump, not to yield perspectives about the future of the IT industries. However, we recognize that our findings invite speculation about the future. In particular, speculation about future IT spending growth rates, given the high rates of spending over the last 5 years, and about potential growth opportunities.

The trajectory of future IT investment is highly uncertain and depends on many key factors: how quickly economic confidence is restored; how quickly the businesses work through the overspending of the last 5 years; and how quickly compelling new applications and offerings emerge on the market that spur business spending (Exhibit 13). Growth rates ranging from 5-17% are plausible. While larger political and macroeconomic factors will play a role, much depends on the ability of IT producers and users to innovate in ways that create real business value.

The experience of the last five years gives hints of opportunities for the IT industries. Given the nature of applications that were most successful (i.e., they were industry-specific, with direct impact on the core activities of firms, and applied to large sectors and to labor intensive activities), IT producers may serve themselves well by developing vertically tailored, business process oriented solutions. The extent of the recent IT investment boom suggests vendors should be developing products that assume a high level of deployed IT infrastructure. They may also benefit from identifying new services that help customers obtain additional value from the hardware they already have in place. Finally, there are still some industry sectors with very low IT capital intensities (Exhibit 14). An additional opportunity for the IT industries is to focus on increasing penetration by tailoring low cost IT solutions to meet the needs of those sectors for which IT applications currently either do not exist or are not cost effective. In all of these efforts, the IT industries must focus on helping businesses make real managerial and process changes.

* * * * *

US productivity growth acceleration was real and a substantial portion of it will endure, but it was rooted in far more than IT. IT is most effective when it is coupled with and helps entrepreneurial managers in competitive industries make product, process, and service innovations. The IT investment boom, on the other hand, resulted from a confluence of unusual factors, and is unlikely to be repeated. The current trough, therefore, is more than a short-term blip upon whose completion investment growth rates will return to late-1990s levels. Innovation driven by competition among IT producers and users will be crucial in returning the industry to higher growth.

CONFIDENTIAL

Exhibits for IT Implications

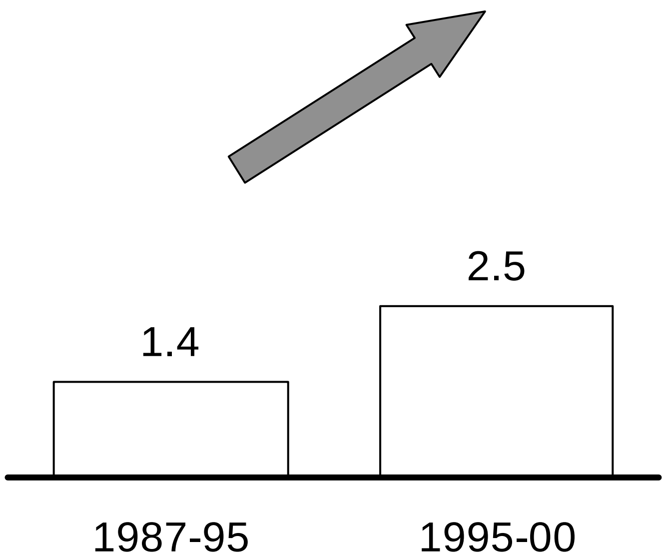
MGI/High Tech Practice

October 16, 2001

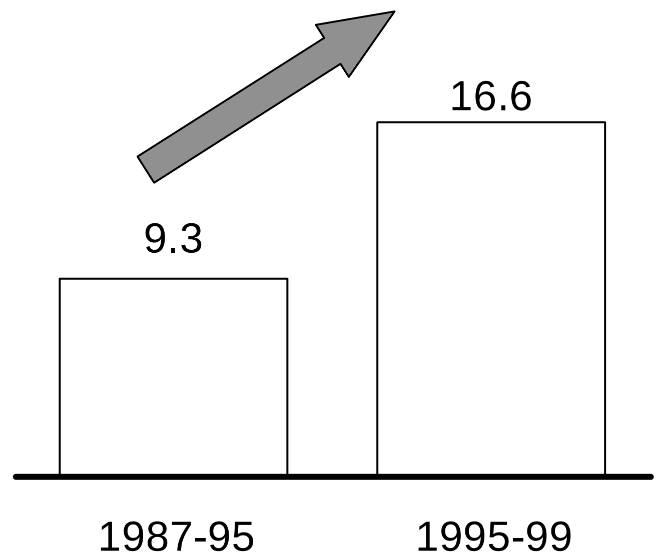
Exhibit 1

A NEW ECONOMY?

Growth in labor productivity*
CAGR



Growth in nominal IT investment
CAGR



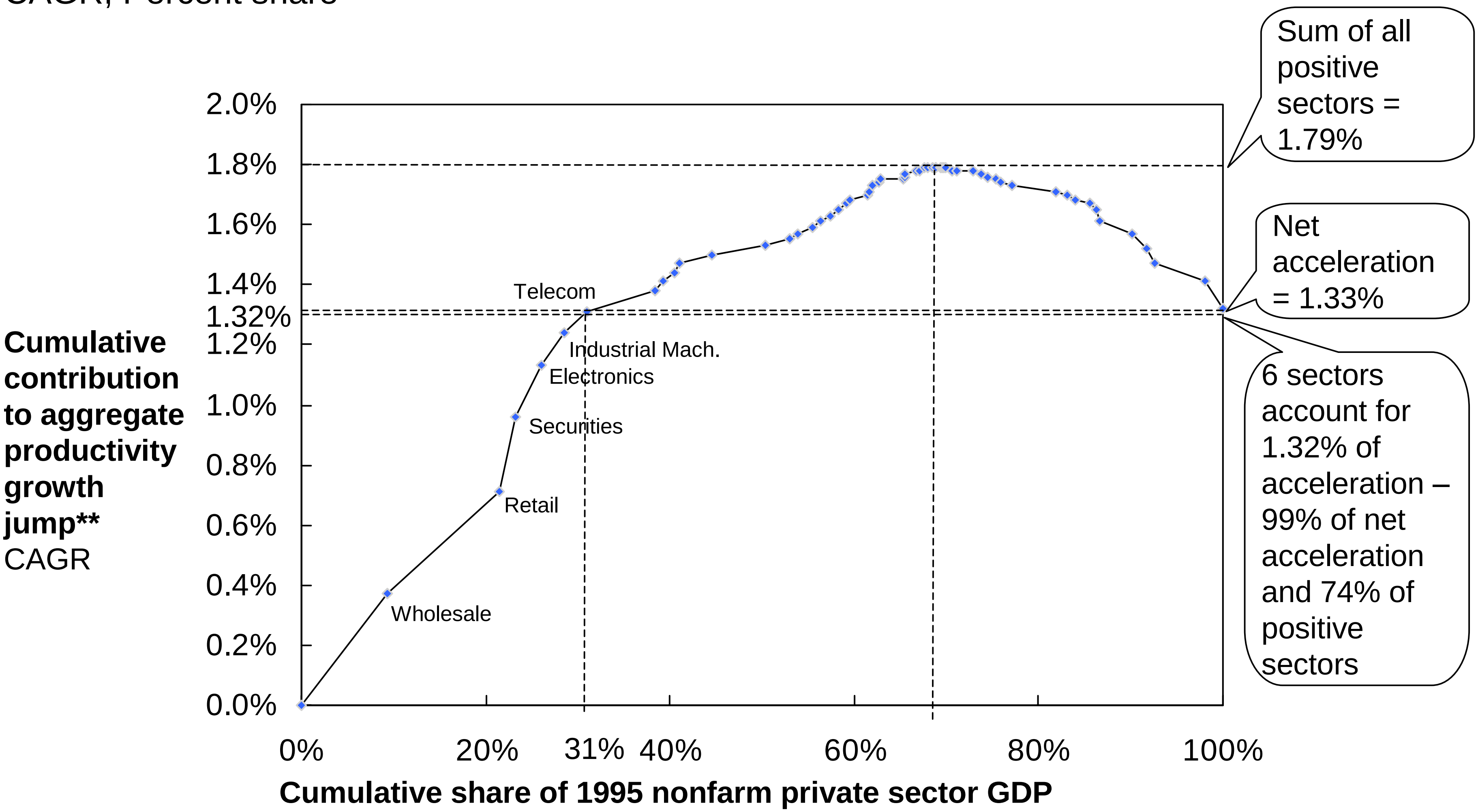
* Excludes output from farms and government; labor productivity is defined here as output per hour worked

Source: BLS

Exhibit 2

CUMULATIVE PRODUCTIVITY CONTRIBUTION DIAGRAM*: 1995 PRODUCTIVITY GROWTH JUMP

CAGR, Percent share



* Sunrise productivity diagram in Arnold Harberger, "A Vision of the Growth Process," AER, Vol. 88, No.1, 1998

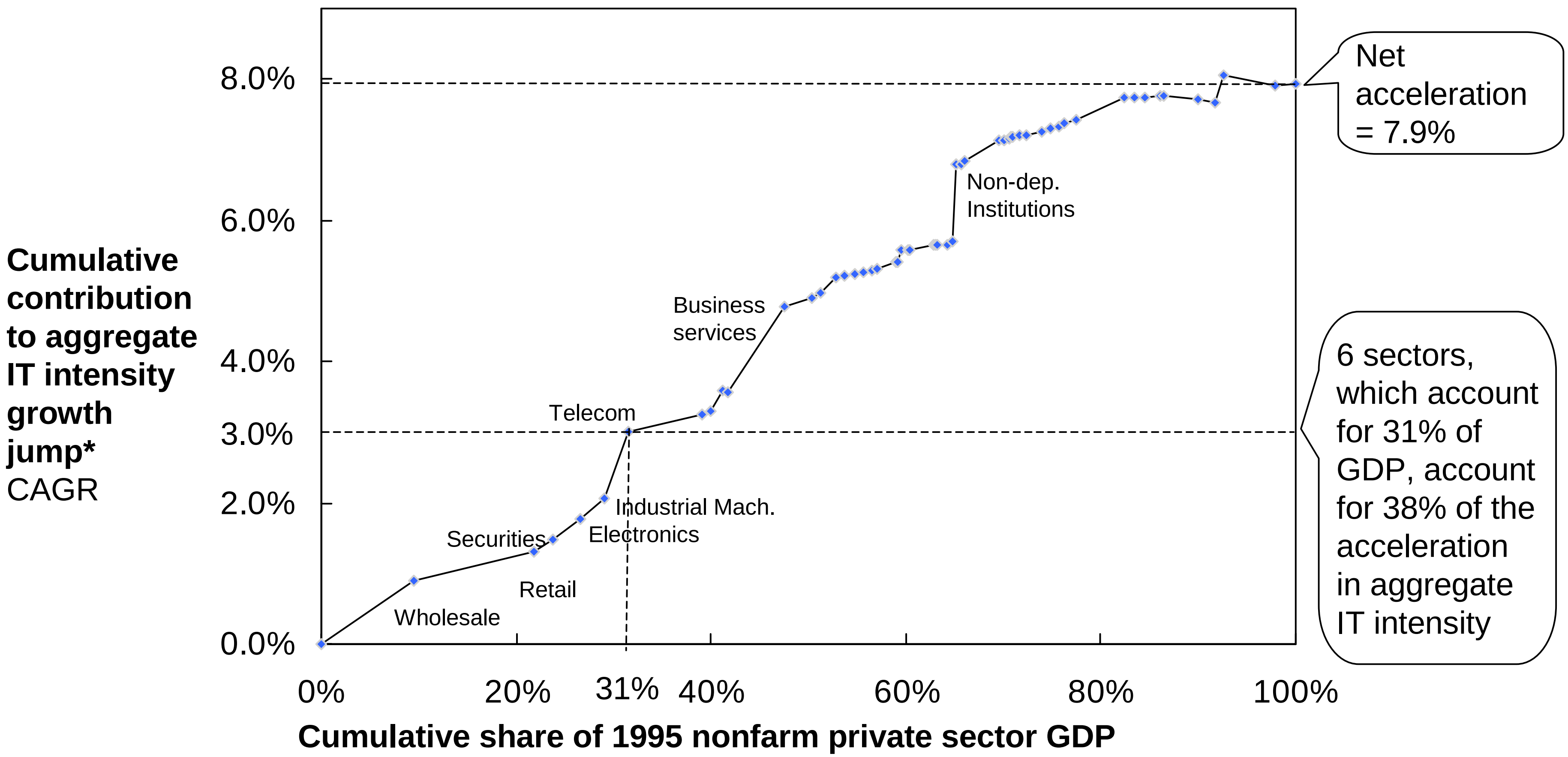
** Excludes contribution of farms and government; holding sector contribution distributed among non top 6 sectors

Source: BEA; MGI analysis

Exhibit 3

CUMULATIVE IT INTENSITY CONTRIBUTION DIAGRAM: 1995 IT INTENSITY GROWTH JUMP

CAGR, Percent share

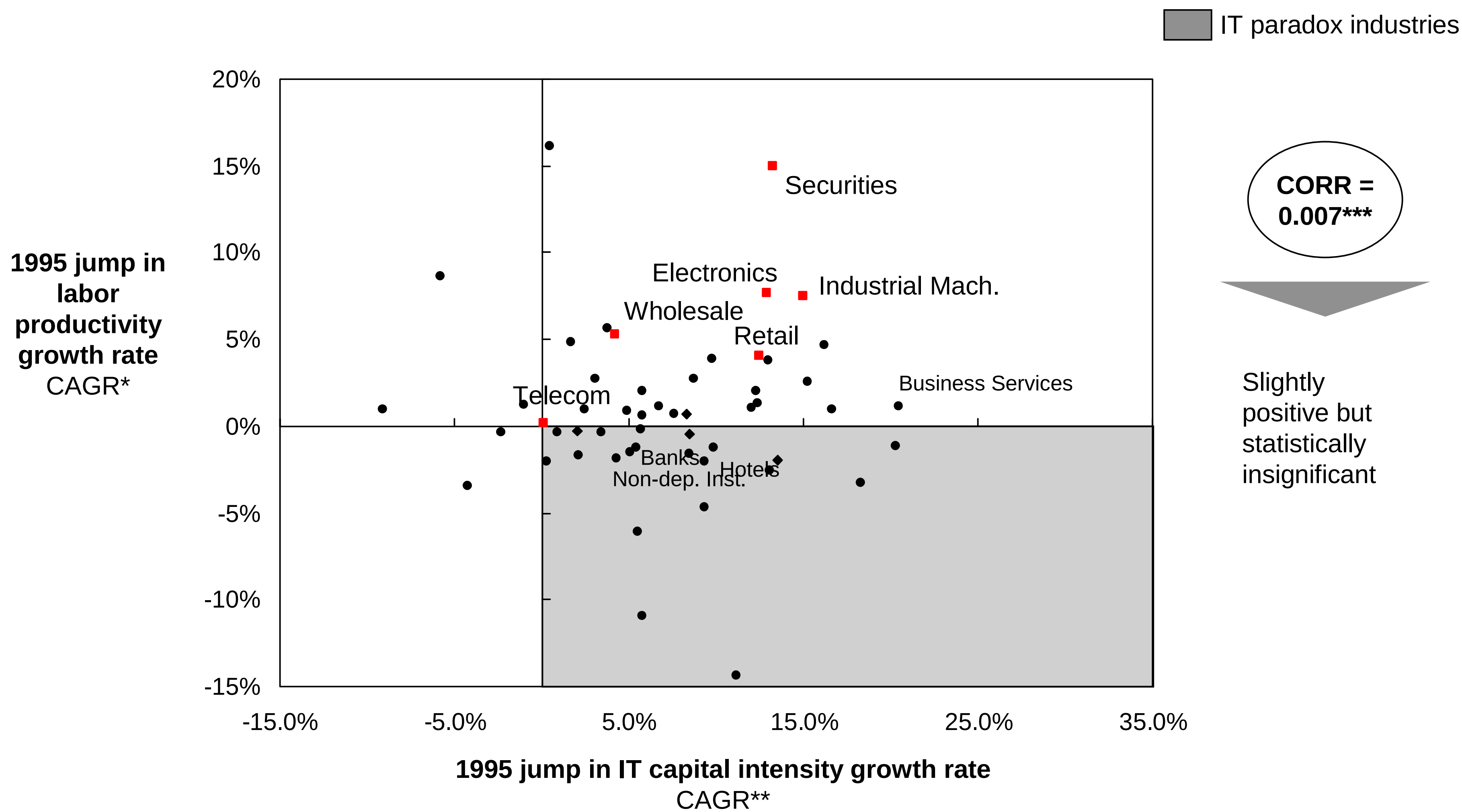


* Excludes contribution of farms and government; holding sector contribution distributed among non top 6 sectors

Source: BEA; MGI analysis

Exhibit 4

INDUSTRY LEVEL CORRELATION BETWEEN IT INTENSITY GROWTH ACCELERATION AND PRODUCTIVITY GROWTH



* Acceleration in real value added per PEP growth rate between 1987-1995 and 1995-1999

** Acceleration in real IT capital stock per PEP growth rate between 1987-1995 and 1995-1999

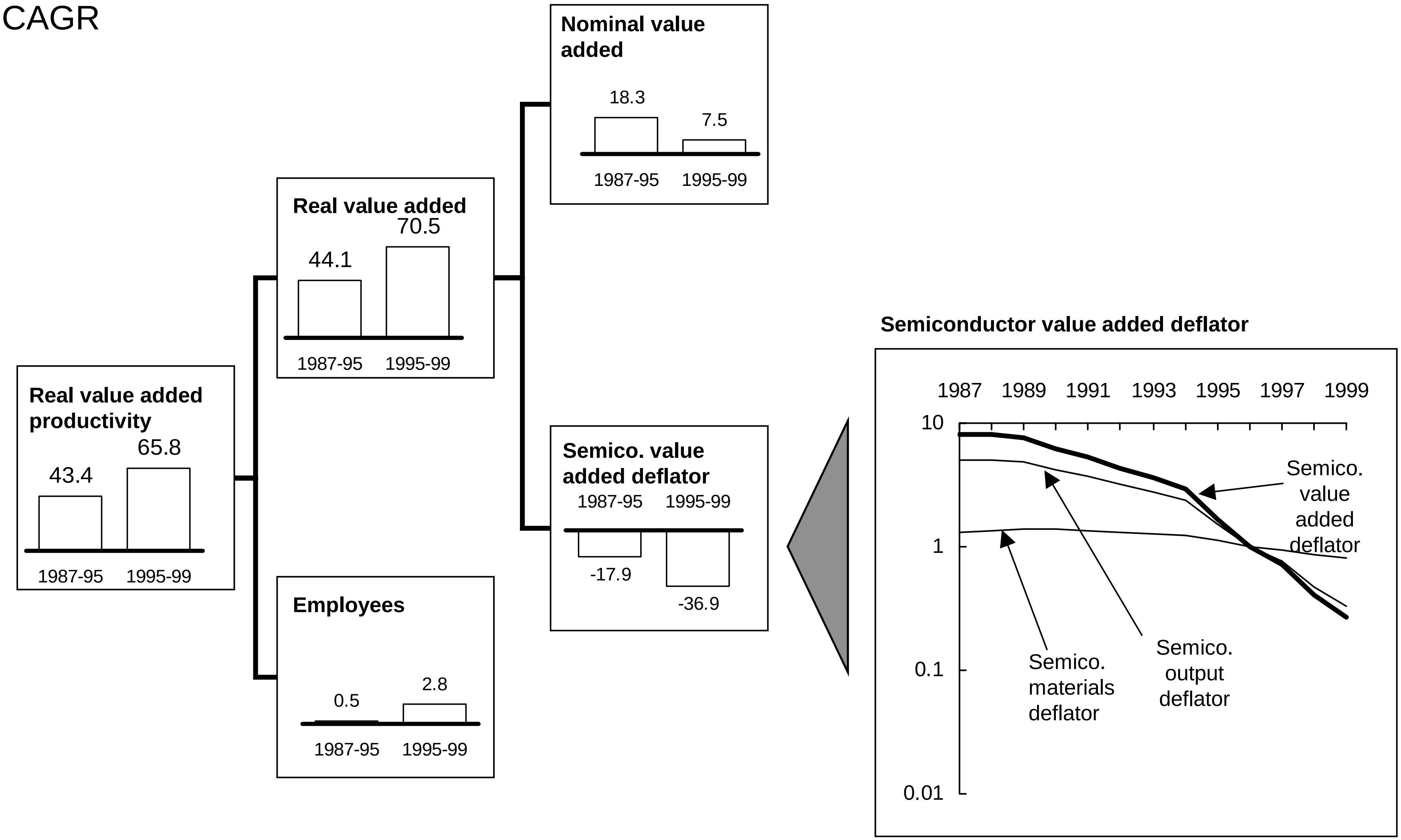
*** Excludes farms, coal mining, and metal mining industries due to low initial levels of IT capital stock and holding companies as outlier

Source: BEA; McKinsey analysis

Exhibit 5

PRODUCTIVITY GROWTH IN THE SEMICONDUCTOR INDUSTRY

CAGR

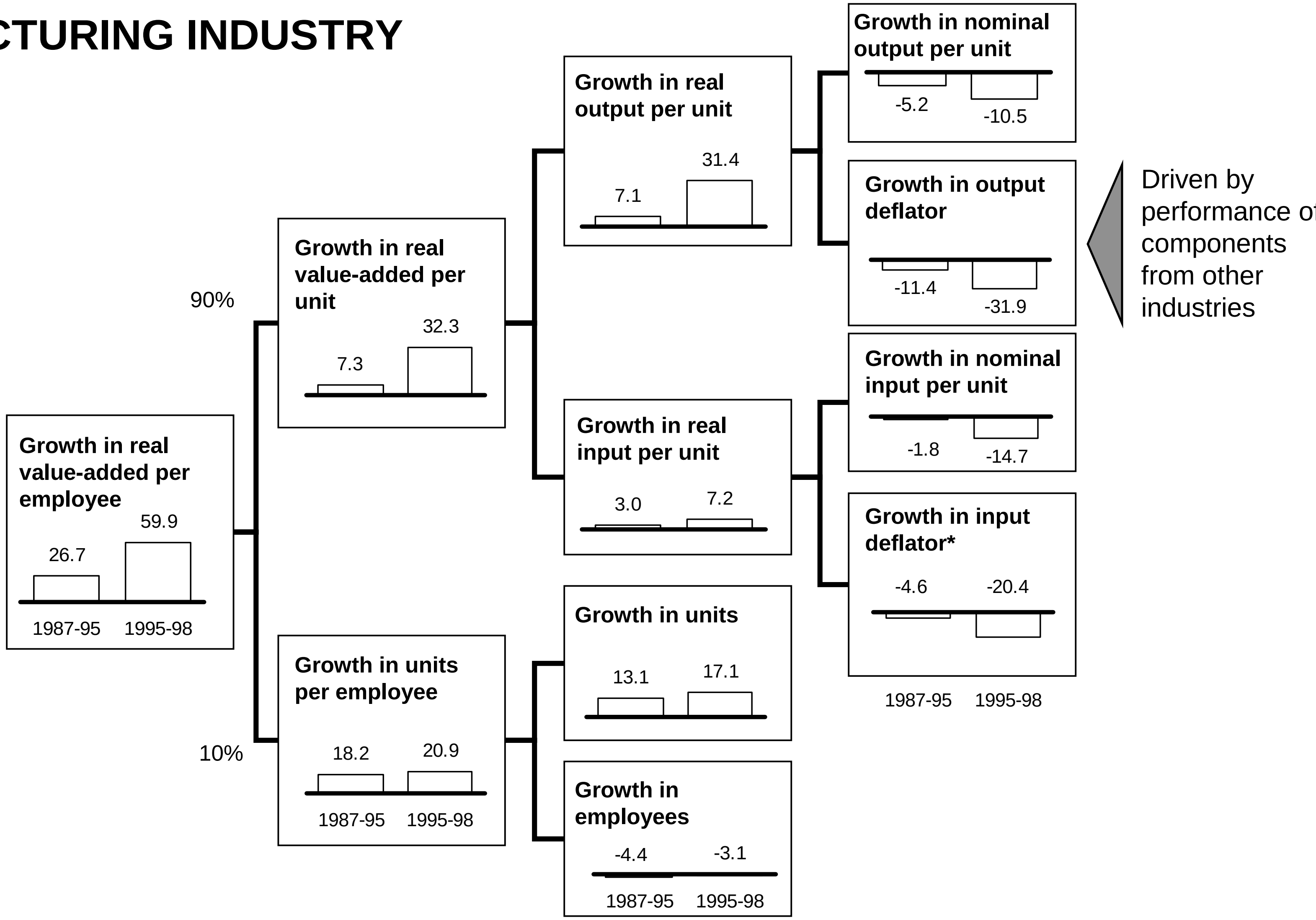


Source: BLS; Census of Manufacturing; NBER; McKinsey analysis

Exhibit 6

PRODUCTIVITY GROWTH IN THE COMPUTER MANUFACTURING INDUSTRY

CAGR



* No input deflator available for 1997 and 1998. Input price deflator decreased by 13.3% in 1996. We assume price of inputs decreases at 23.7% CAGR for 1997 and 1998 to take into account the faster decline in microprocessors due to higher levels of competition in 1997 (see semiconductor case for details).

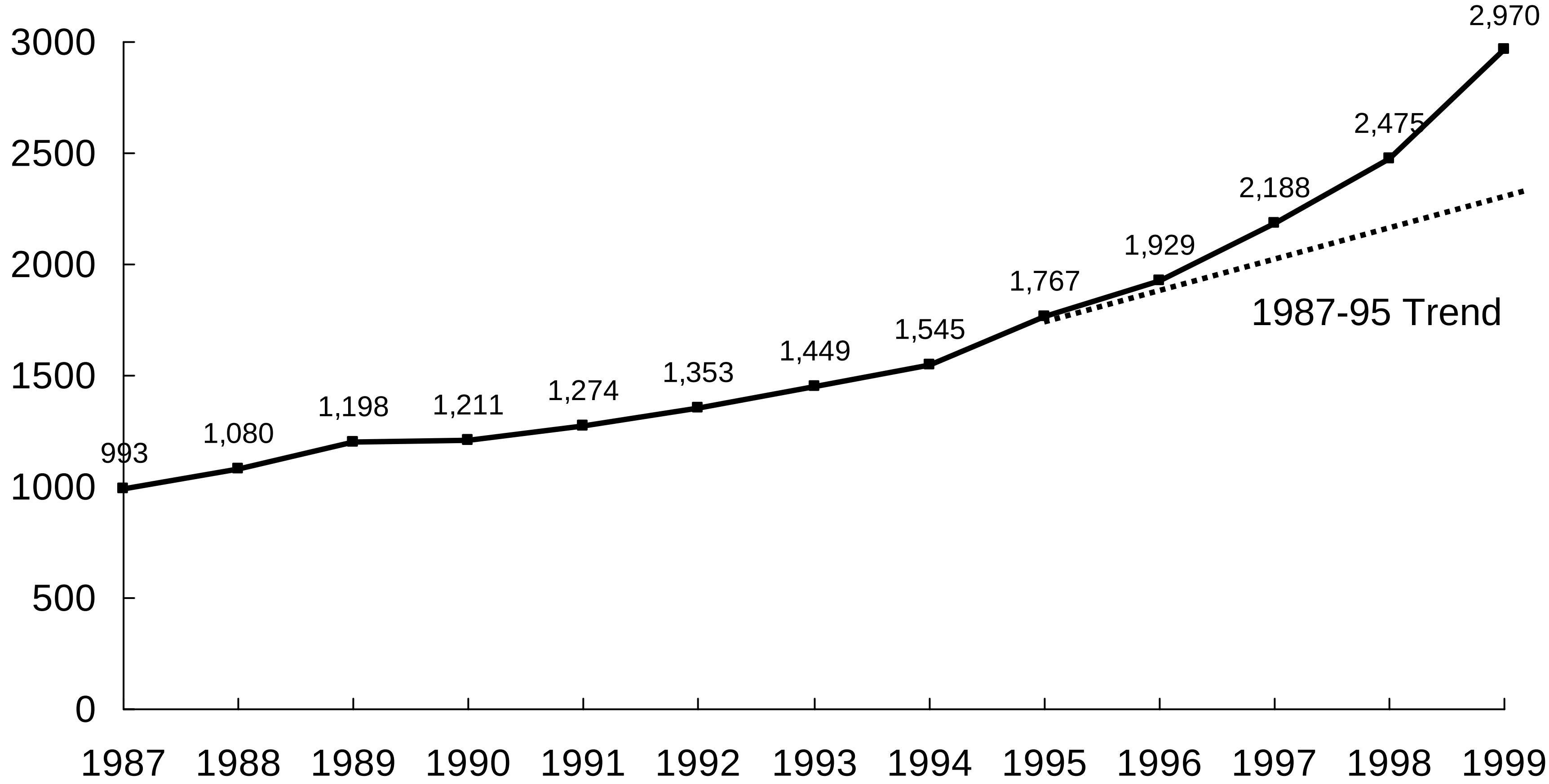
Source: NBER; U.S. Bureau of Census; Dataquest; BLS; McKinsey analysis

Exhibit 7

IT INVESTMENT ACCELERATED IN 1995 REACHING, CLOSE TO $3,000 PER EMPLOYEE PER YEAR BY 1999

IT Investment per Employee*

$ per employee



* Employee is defined as PEP (persons engaged in production). It is the sum of FTE (full time equivalent) and self-employed.

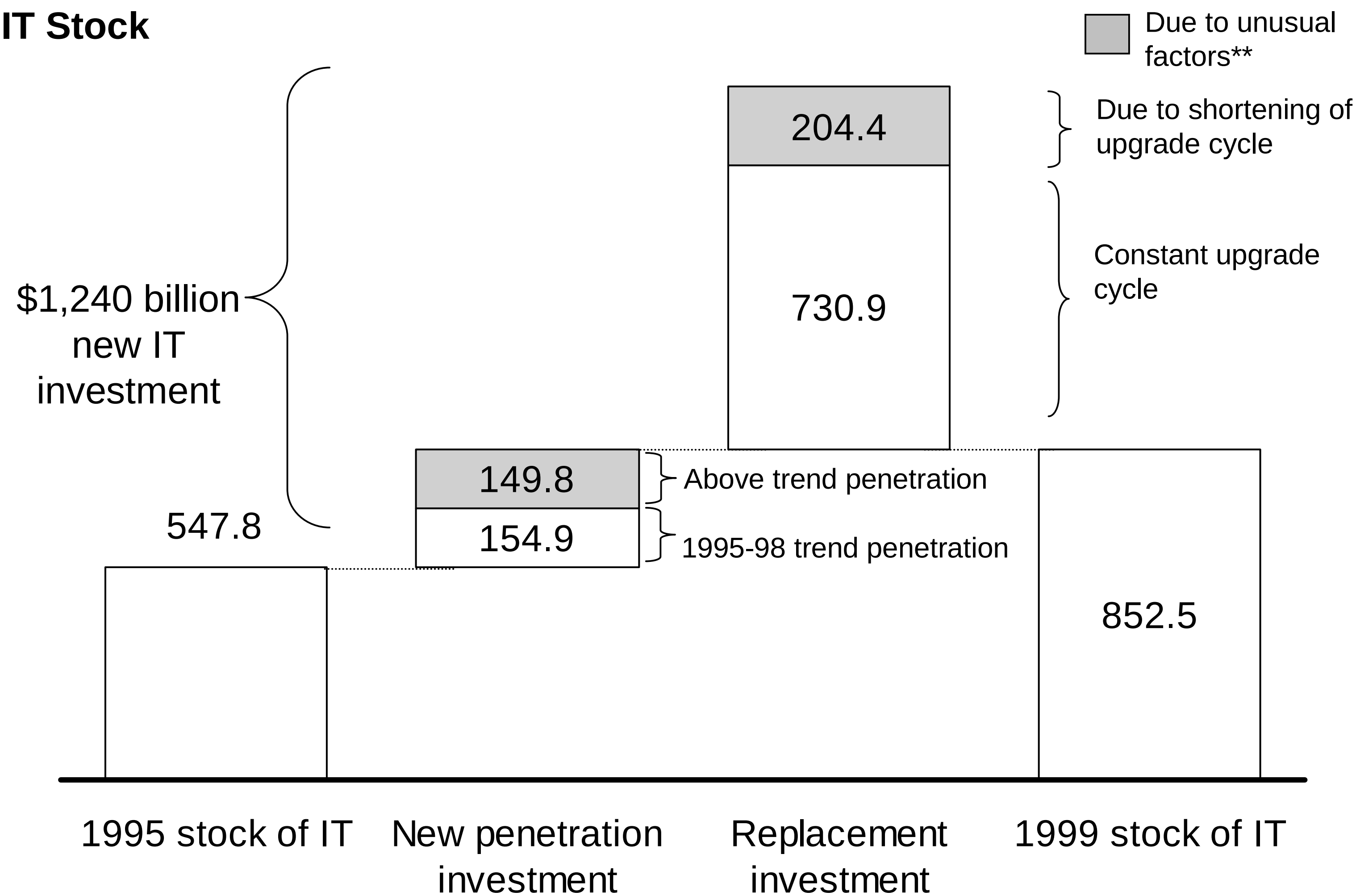
Source: BEA; McKinsey analysis

Exhibit 8

ROUGHLY $350 BILLION* OUT OF $1,240 BILLION IN IT INVESTMENT MADE BETWEEN 1995-99 WAS DUE TO UNUSUAL FACTORS

Nominal IT Stock

$ billions



* Sum of $149.8 billion and 204.4 billion.

** Y2K, the emergence of the Internet, the initial buildup of corporate networking infrastructure, and rapid PC upgrade cycles

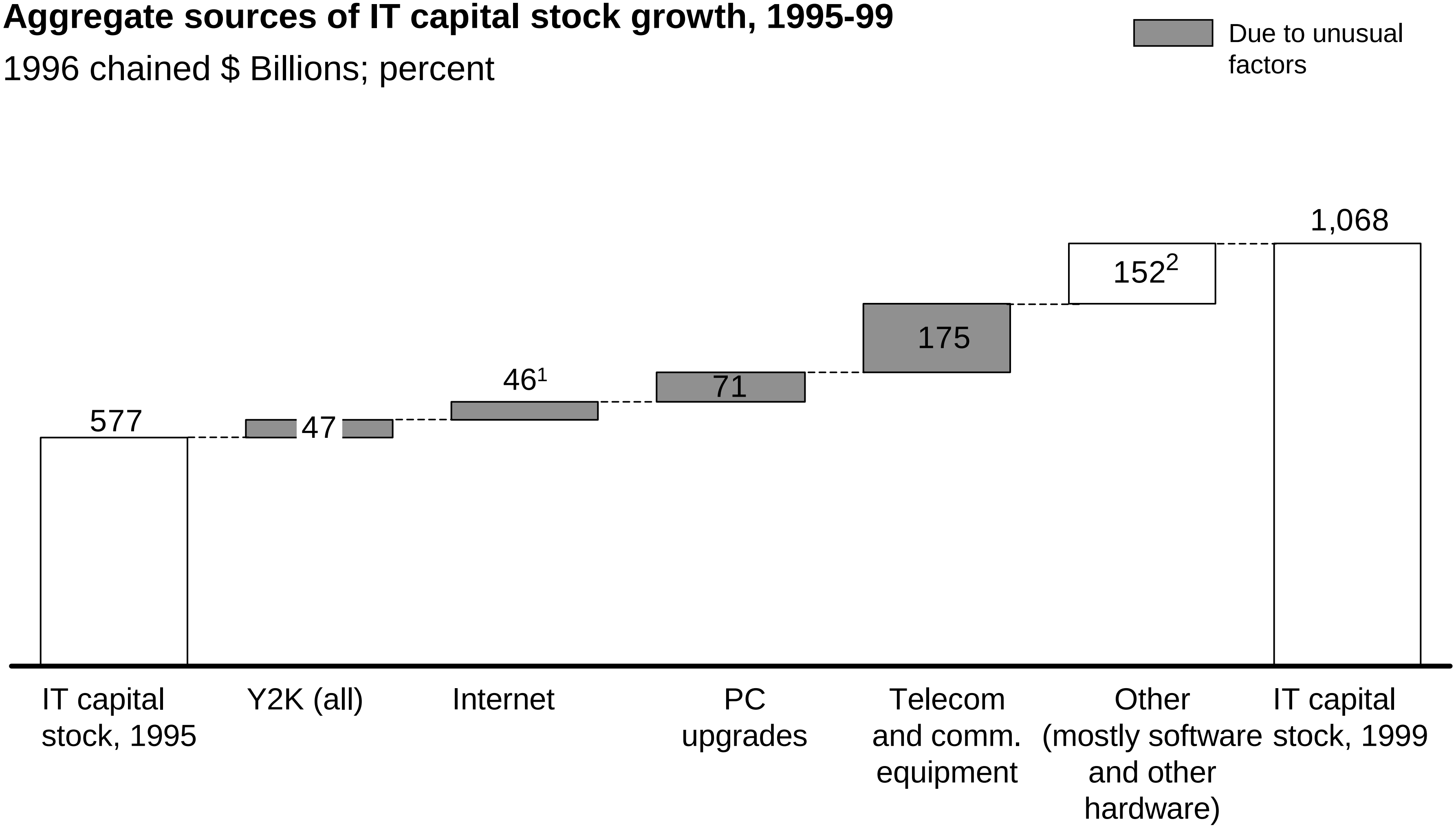
Source: BEA; McKinsey analysis

Exhibit 9

REAL IT CAPITAL STOCK, WHICH TAKES INTO ACCOUNT PERFORMANCE IMPROVEMENT, NEARLY DOUBLED, 1995-1999

Aggregate sources of IT capital stock growth, 1995-99

1996 chained $ Billions; percent



1 Excludes 2000, the largest year of internet investment ($36 billion, nominal)
2 Cumulative capital addition and depreciation

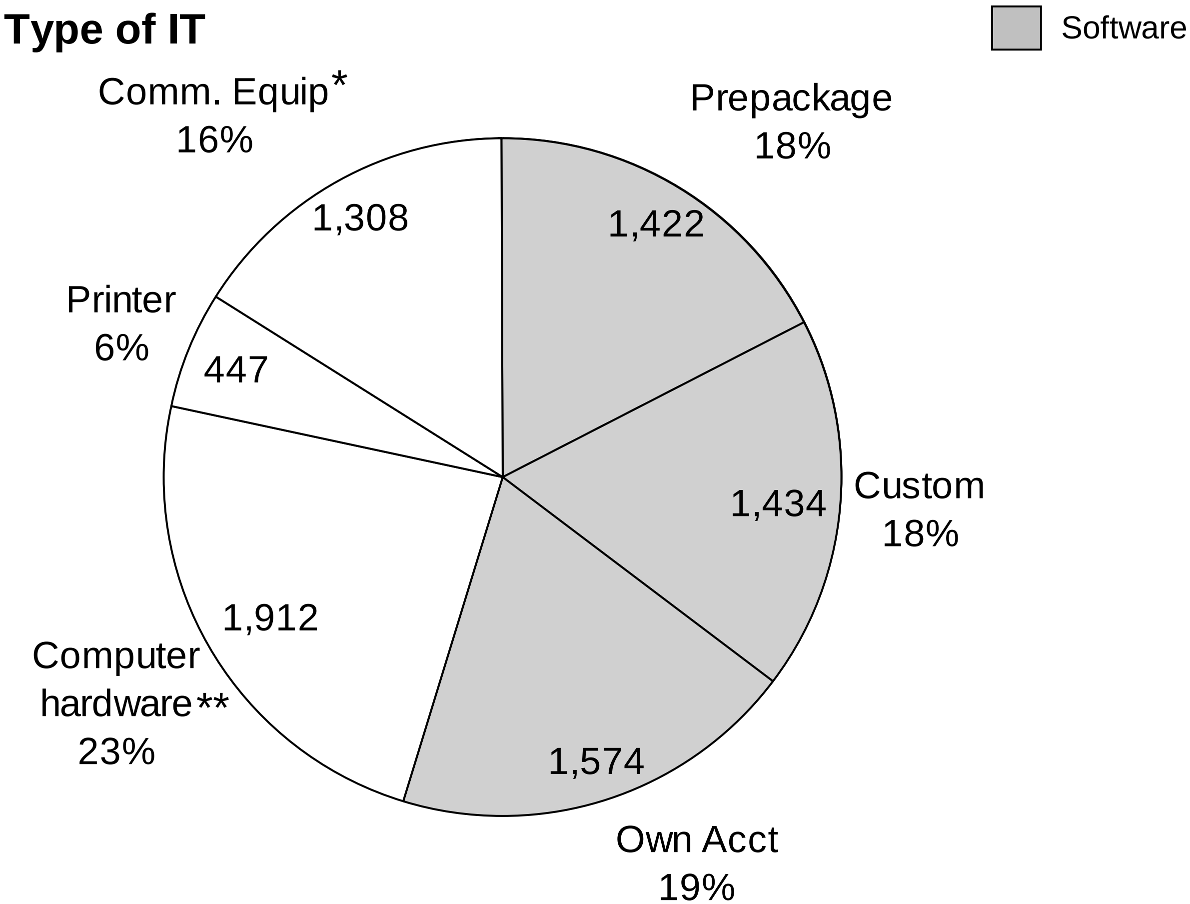
Source: BEA; 10K filings; IDC; Dataquest; Gartner; Rubins; Tower Group; McKinsey analysis

Exhibit 10

BY 1999, AN AVERAGE EMPLOYEE WAS EMPOWERED WITH OVER $8,000 WORTH OF IT CAPITAL STOCK

1999 IT Intensity by Type of IT

Percentage share



100% = $8,096

* Excludes communication equipment investments of telecommunication service sector

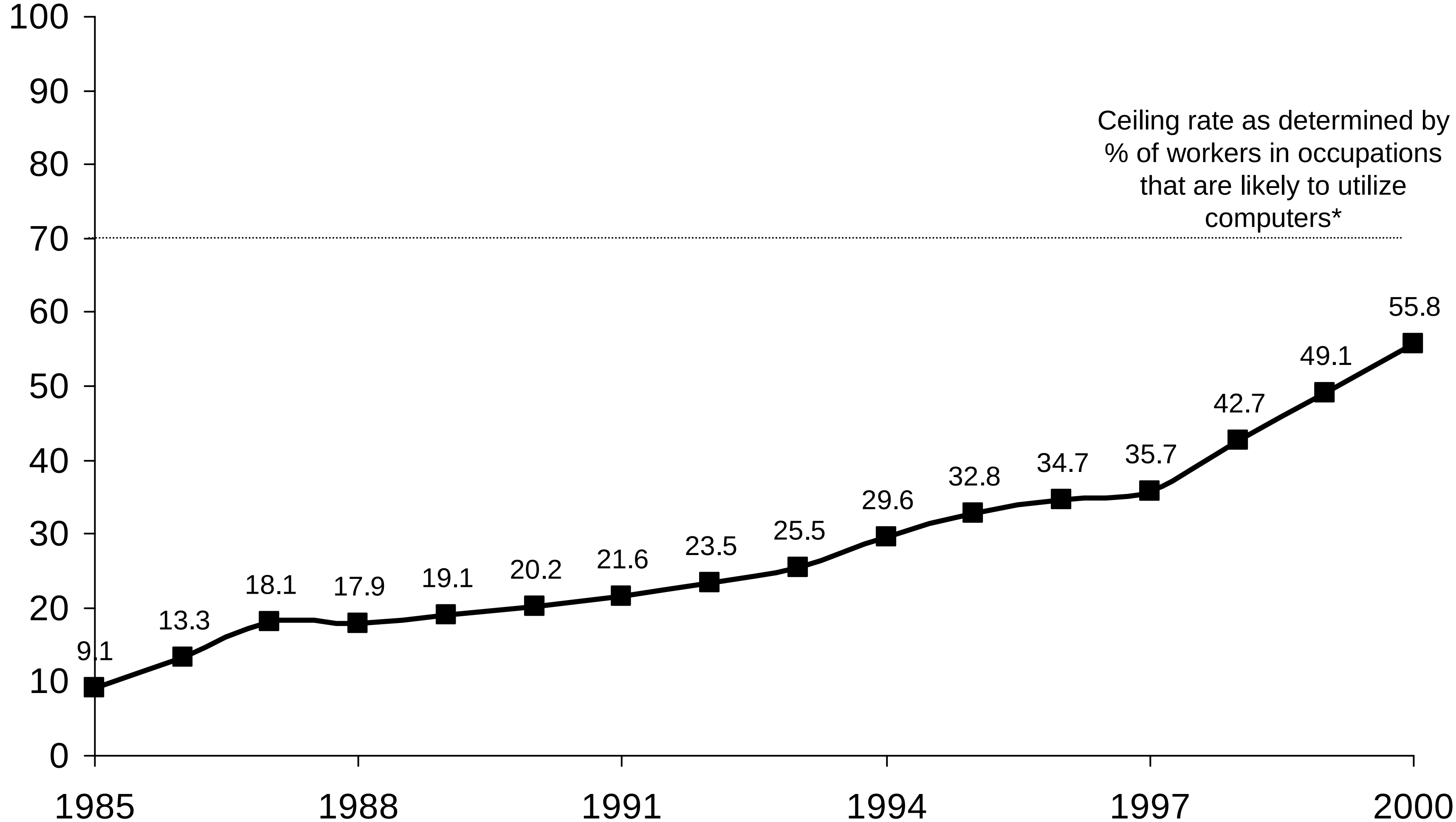
** Includes PCs, servers, mainframes, terminals, and storage devices.

Source: BEA; McKinsey analysis

Exhibit 11

BUSINESS PC PENETRATION IS APPROACHING ITS UPPER THRESHOLD

Percentage of persons engaged in production



* BLS Occupation-Industry matrix reveals that ~70% of employees are in occupations that are likely to benefit from direct utilization of computers.

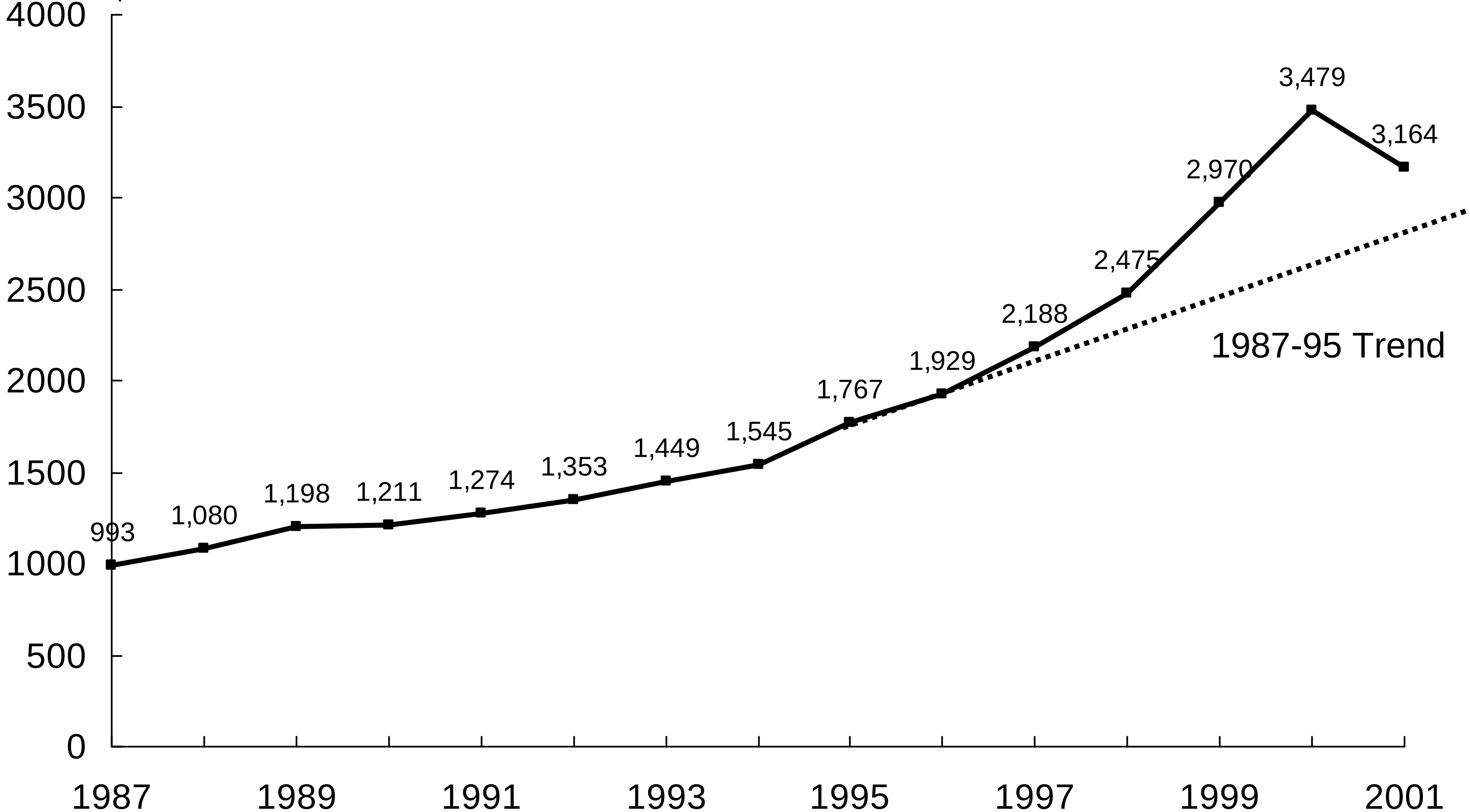
Source: MGI analysis

Exhibit 12

IT INVESTMENT SPENDING HAS NOW FALLEN AND IS NOT LIKELY TO RETURN TO THE 1995-99 GROWTH RATE IN THE NEAR FUTURE

IT Investment per Employee*

Nominal $

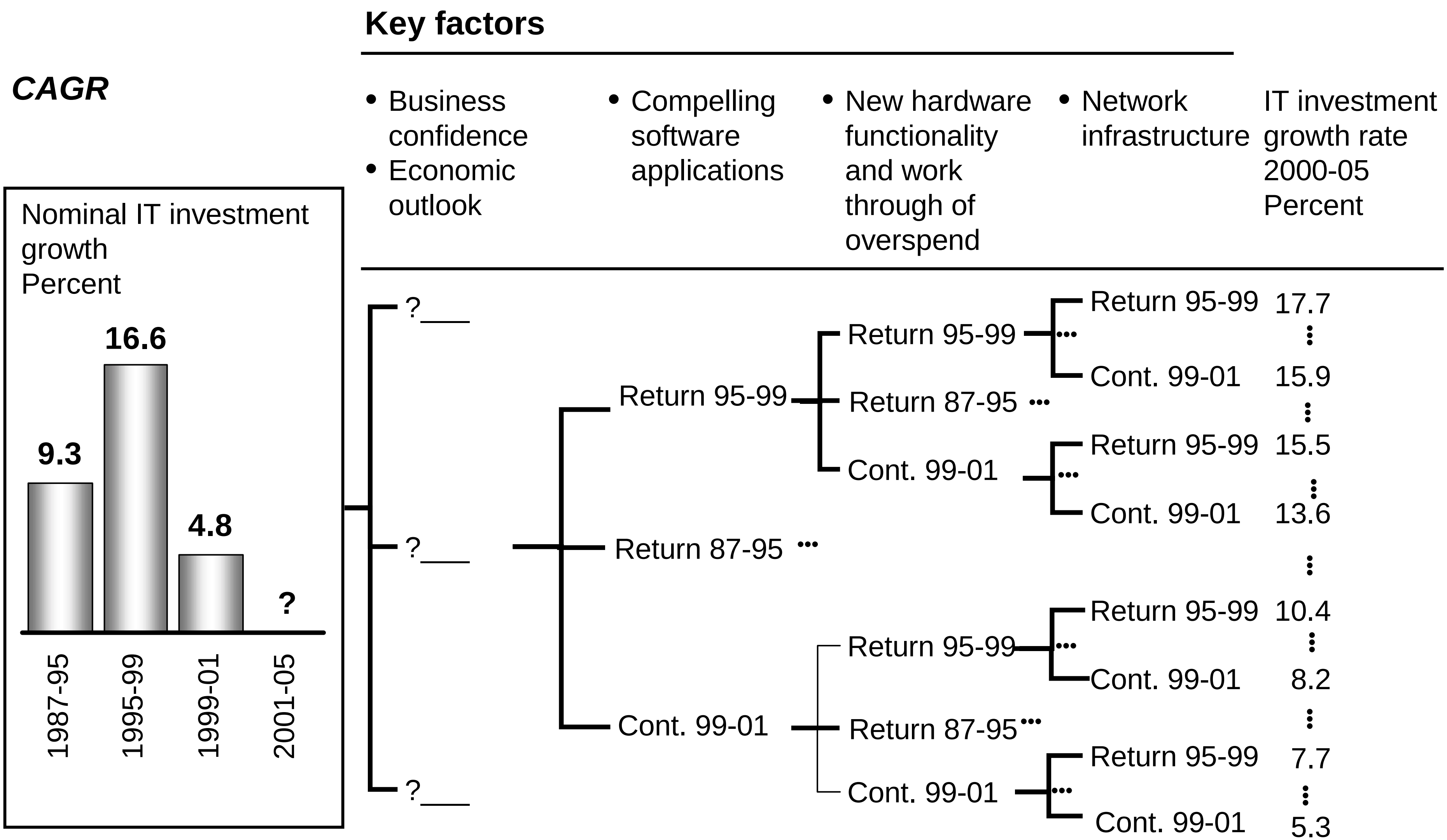


* Employee is defined as PEP (persons engaged in production). It is the sum of FTE (full time equivalent) and self-employed.

Source: BEA; McKinsey analysis

Exhibit 13

KEY FACTORS WILL DETERMINE FUTURE IT INVESTMENT GROWTH



Source: BEA; McKinsey analysis

Exhibit 14

IT INDUSTRY WILL HAVE TO TAILOR STRATEGIES TAKING INTO CONSIDERATION VARIATIONS IN SECTOR IT CAPITAL INTENSITIES

1996 $ indexed

Rank	Sector	1999 IT capital stock per employee
1	Telephone and telegraph	226,711
2	Pipelines, except natural gas	152,864
3	Nondepository institutions	134,670
4	Radio and television	125,679
5	Electric, gas, and sanitary services	34,574
•	•	•
•	•	•
•	•	•
55	Health services	1,156
56	Amusement and recreation services	1,103
57	Construction	1,030
58	Farms	885
59	Educational services	618

Measurement appendix

SUMMARY

The research effort behind this report, which drew upon public data sources, gave MGI new appreciation for the enormity of the task facing the government entities that measure and report economic statistics. In the course of our work, we became aware of – and in some cases developed potentially fresh insights on – several specific measurement challenges. This measurement appendix seeks to collect these findings in one place, in hope that they will be of use to both the producers and consumers of the data developed by government statistical agencies. There are 7 topics addressed in this measurement appendix:

¶ **Measuring output in software.** This section contains an exploration of function points as a potential alternative to the current software deflator. It concludes that function points may be a preferable method, but that employing them would not have a meaningful impact on overall productivity results.

¶ **Retail and wholesale challenges.** This section summarizes the data challenges posed by the retail and wholesale sectors, and suggests potential improvements for them.

¶ **Automotive findings.** This section discusses the challenges associated with developing a valid productivity measure for the automotive sector due to the incompatibility of data sources from varied government statistical agencies.

¶ **Communications equipment.** This section describes the methodology used to develop a new price index for communications equipment, to better reflect the price-performance improvements that have taken place over the past decade.

¶ **Refining the securities sector's output measure.** This section discusses the challenges of measuring the output of key services provided by the securities industry, e.g., equity trading, portfolio management, and described MGI's suggested improvements to their measurement.

¶ **Refining the depository institutions' output measure.** This section discusses the refinements made by MGI to the BLS' measure of retail banking output and productivity.

¶ **Holding and other investment offices.** This section describes MGI's investigation of Holding and other Investment Offices (SIC 67), a sector that appeared upon initial analysis to be a key contributor to the economy-wide productivity growth acceleration. It concludes that the sector's performance was likely attributable to classification improvements made by the IRS to the business receipts that drive the sector's gross output figures.

Measuring output in software

EXECUTIVE SUMMARY

Accurate measurement of the output of the software industry is becoming increasingly important for accurate measurement of economy-wide labor productivity[1]; by 1999, non-government investment in software (or "private" software investment), grew to represent 41.6 percent of private information technology investment (in nominal terms), 11 percent of all private investment, and 1.9 percent of gross domestic product (GDP). Unfortunately, the output of the software industry is difficult to measure because of the varied forms its output takes, ranging from Microsoft Word to massive, custom-built billing systems.

McKinsey Global Institute (MGI) found that the current Bureau of Economic Analysis (BEA) software price indexes understate the rate of price decline for Business Own-Account software and Custom software. Using a metric known as function points (FP) for these two types of software, MGI determined that the rate of price decline for all of software increases to a compound annual growth rate of –5.3 percent, versus the –1.3 percent reported by the BEA for the 1987-99 period (Exhibit 1). The FP metric quantifies the amount of data manipulation capacity that a piece of software provides to an end user. Other effects of applying the MGI prices indexes for software include:

¶ Essentially no change in the delta[2] in the economy-wide growth rate

¶ A decrease in the delta, from 5.4 percent to 5.0 percent, in the rate of labor productivity within the software sector itself

¶ An increase to 18.9 percent in the annual rate of growth in the real stock of software, versus the currently reported 13.8 percent from 1987 to 1999.

Given the limited impact of the new MGI software price indexes on the delta in the economy-wide rate of labor productivity, MGI did not pursue a full analysis of the operational drivers causing the labor productivity growth in software. We refer interested readers to the synthesis chapter and to other sector case studies to see the operational impact of software on the industries that use it.

---

1 Labor productivity is measured here as the total real GDP in a year over the total number of people employed in production (PEP)

2 Delta is defined as the difference between the 1995-99 and the 1987-95 growth rate.

INTRODUCTION

The primary goal of this MGI study was to understand if the surge in US labor productivity between 1995 and 1999 (versus 1987 to 1995) is sustainable. MGI also sought to understand the impact of information technology (IT) investment on labor productivity. In answering these broader questions, MGI also sought to determine the extent to which inaccurate measurement of software investment would reduce or increase the difference between the labor productivity growth rate during 1995-99 versus 1987-95.

The importance of the software industry to the US economy is growing. In 1999, software represented 1.9 percent of GDP and 0.8 percent of US employment, up from 0.7 percent of GDP and 0.4 percent of employment in 1987. Software has also grown from 22.1 percent of IT investment[3] in 1987, to 41.6 percent in 1999 (Exhibit 2). Additionally, in 1998, software was reclassified as an investment good, so any increase or decrease in the measured output of software directly impacts GDP. Hence, accurate measurement of the output of the software industry is becoming increasingly important for accurate measurement of economy-wide labor productivity.

Unfortunately, the output of the software industry takes many forms – ranging from Microsoft Word to massive, custom billing systems – and the data sources that track this fragmented and diverse industry are limited. MGI intended to understand how the current BEA price indexes (Exhibit 2) for software are constructed and if the price indexes accurately measure the price changes in software, given the known complexity of defining what constitutes "units" of software output.[4]

BEA categorizes investment in software into three areas:

¶ **Prepackaged software.** Software designed for use by many different users, with limited or no additional customization required (e.g., Microsoft Word, and SAP's licensing revenues).

---

3 Defined here as a percentage of the BEA category "Private Fixed Investment in Equipment and Software," which includes telecom equipment

4 As an example of the use of price indexes, suppose a sector has nominal sales that increase from $100 to $110 billion, or by 10 percent. If the price index for the sector increases by 4 percent over the same period, then the implicit real growth will be ~6 percent. Similarly, if the price index were to decrease by 8.0 percent, then the implicit real growth rate will be ~20 percent. The quantity growth rates from different components of the economy are aggregated by the BEA, using a Fischer Ideal index, to produce the real GDP growth rate widely reported in the media. As a result, better measurement of prices in a sector can change the measured growth rate of that sector, the GDP, and of labor productivity

- **Custom software.** Software custom-built by a firm specifically for use by another firm (e.g., a trading application built for Goldman Sachs by Accenture Consulting).[5]

- **Business Own-Account software.** Software built by a company for its own internal use (e.g., a trading application built for Goldman Sachs by its internal staff).[6]

It is generally agreed that computer processing power is becoming less expensive, but there is a less uniform opinion regarding the price-to-performance improvements in software. Those familiar with the industry cite several process changes that suggest the cost of producing software is decreasing, including:

- Better communication tools (e.g., e-mail)

- More structured development methods

- Increased use of code libraries and higher-level programming languages.

Additionally, in Prepackaged software, scale effects are driving labor productivity. An increase in the size of the computer-using population causes an increase in labor productivity growth, as long as growth in "total labor input" is less than the growth in "total number of applications sold."[7]

This paper lays out the results of the MGI analysis of the output of the software sector in three main sections:

- **The current BEA price indexes.** Explains the methodology BEA currently uses to calculate the price indexes for the three components of software investment.

- **Options for improved software price indexes.** Outlines the various options for measuring output that could potentially be used to improve the existing price indexes, and then explains why MGI decided to use function points (FPs).

- **The new MGI price indexes and their impact.** Presents the results of using FPs to measure output in Business Own-Account and Custom software. This section also provides the results of an analysis of the potential upper bound of the rate of price decline in software.

---

5 Category does not include the consulting revenues from the implementation of Prepackaged software (e.g., the money Accenture consulting is paid for installing SAP)

6 Does not include data processing

7 Actually calculating the impacts of scale on labor productivity requires a more complex treatment than the intuitive explanation offered in the text

THE CURRENT BEA PRICE INDEXES

The BEA has made a strong effort to estimate the rate of price decline in the software sector. The estimation problem is fundamentally a very difficult one to solve, and the BEA has tackled it in the face of limited resources. While MGI was attempting to understand and potentially improve on the current estimates, the BEA was helpful in providing information.

Understanding and assessing BEA's methodology for estimating the software price indexes

From 1987 to 1999, the current BEA price indexes (Exhibit 2) show a large decline in the price of Prepackaged software, a price increase in Business Own-Account software, and almost no change in the price of Custom software. These price index trends reflect the choice of methodology used to estimate them.

¶ **Prepackaged software**

- **BEA methodology.** Between 1985 and 1993, the Prepackaged price index is a 50/50 combination of a hedonic index[8] and a matched model[9] index. Between 1993 and 1998, it is based only on the matched model index, with an upward bias adjustment. Price declines prior to 1985 are estimated by looking at the relationship of the Prepackaged index relative to the Computer and Peripheral index between 1986 and 1997, and extrapolating this relationship back to 1959 (Exhibit 3).

- **Assessment.** While BEA's approach of combining a variety of methods is somewhat arbitrary, it represents a best effort to solving a difficult challenge. Two key problems in BEA's approach are:

  – The basket of applications measured is not representative of the broader Prepackaged software industry. The hedonic data is based on spreadsheet and word processor applications, which today account for only about 4 percent of packaged software sales. The matched model approach appears to only add database applications to the sample.

  – The matched model approach does not take into account the quality improvements that occur between versions of software; for

---

8 Hedonic techniques enable quantitative quality adjustments between different products. See technical appendix for more detail

9 Matched Model tracks the price changes over time in products. The same products are used year after year, hence the term "matched model." For further detail, please refer to the technical appendix

example, it would consider Word 2.0 to be the same product as Word 7.0. Not surprisingly, this approach suggests a measured rate of price decline that is significantly less than the hedonic approach suggests.

¶ **Business Own-Account software**

- **BEA methodology.** In estimating the Business Own-Account price index, BEA currently assumes no productivity gain. The annual price increase estimated is a reflection of increase in the median price of a business employee in the US economy, including the costs of salary, all additional compensation, and overhead. In the face of limited data, BEA often defaults to estimating the price changes in the output of a sector based on the price changes in the inputs to the sector.

- **Assessment.** Given substantial changes in communication techniques, development methods, languages, tools, and code libraries, the assumption of no productivity growth is unlikely to be correct. (The BEA is aware of this issue.)

¶ **Custom software**

- **BEA methodology.** BEA estimates the Custom software price index by weighting the "annual rate of change in the price index for Business Own-Account software" by 75 percent, and the "annual rate of change in the price index for Prepackaged software" by 25 percent.

- **Assessment.** The current methodology for estimating the Custom software price index is an arbitrarily weighted average of two already imperfect indexes, and hence has a low probability of accurately reflecting reality.

OPTIONS FOR IMPROVED SOFTWARE PRICE INDEXES

After understanding BEA's approach, MGI sought to improve on the current price index estimates. Eventually, MGI settled on FPs as an output measure for software, given its conceptual and data-availability advantages over the other options we identified.

Understanding the range of output measures possible

MGI identified three key options for measuring output: hedonic adjusted applications, lines-of-code,[10] and the FP metric. The range of options can be most easily understood by thinking in terms of "layers of abstraction" (Exhibit 4). At the highest layer of abstraction, "applications, adjusted for feature quality," the measure of output is closest to what customers value. However, it also involves the most subjective measuring process. At the lowest layer of abstraction, lines-of-code, the measuring process is very objective. However, the metric relates the least to what customers actually value.

FPs constitute an intermediate layer of abstraction that quantify the amount of data manipulation capacity that a piece of software provides to an end user. A FP count is calculated by:

- ¶ Adding up the data manipulation capacity of all transactions
- ¶ Adding up the data manipulation capacity of all data tables
- ¶ Adjusting the total count for the softer factors that make the total data manipulation capacity more or less “available” to an end user.

To some degree, an FP count represents the opportunity cost of not using software to do data manipulation; the higher the FP count, the more time that would be required without the software. Software companies, in general, strive to create FPs that are useful to end users and to eliminate coding that is not useful. Competitive markets and profit incentives enforce this principle. FPs are explained in more detail in Exhibits 5 and 6.

Why function points were chosen as the best measure of software output

MGI settled on FPs as the best measure of output and developed a new FP-based price index for two reasons. First, MGI was not able to develop a hedonic-based price index for Prepackaged software due to data availability challenges, and a

---

10 "Lines-of-code," as used here, is meant to include other low level but equally objective measures, such as size of the executable shipped, size of the average installed footprint, etc.

hedonic-based index cannot readily be developed for Business Own-Account or Custom software because the feature sets in those products are mostly unique. Second, MGI found that lines-of-code-based measures were conceptually inferior to FPs and exhibited even more serious data availability challenges (Exhibit 7).

¶ **"Hedonic" challenges.** Conceptually, it is not possible to construct a hedonic-based price index for Business Own-Account or Custom software. For Prepackaged software, while a hedonic-based price index is theoretically possible and would be preferable over the other options, there is insufficient data to construct such an index.

- **Constructing a hedonic index for the Business Own-Account and Custom sectors is not feasible.** The task would require looking at buyers making price-to-quality trade-offs over time. However, the code developed by these two sectors is highly specific and has features that are frequently not comparable over time, or across users.

- **Constructing a hedonic-based price index for Prepackaged software is challenging due to lack of data.** The existing hedonic price indexes are based on data from the National Software Testing Laboratory (NSTL). NSTL data was only published for a small number of widely used applications during a period when the markets for those products were highly competitive (i.e., spreadsheet and word processing applications in the late 1980s). MGI was not able to locate any other data sources comparable to what NSTL had published, and NSTL confirmed the lack of any other comparable data sources. Hence, MGI's ability to make further extensions to the hedonic index, beyond what had already been done by academics and BEA, was capped. Additionally, the selection bias in the NSTL data caused MGI to infer that any hedonic index constructed from it would overstate the price declines of the broader Prepackaged software sector.

¶ **"Lines-of-code" challenges.** Lines-of-code, the lowest layer of abstraction, is a metric that is both less conceptually attractive than FPs and presents more difficulties with data availability.

- **Lines-of-code is a less conceptually attractive metric than FPs.** Compared to FPs, the metric does not map as closely to the criteria end users use to purchase software. Furthermore, lines-of-code counts from different years become less comparable over time, as programming language standards change and as the average programming style changes, leading to increased or decreased code per line. Interestingly, FPs can be used to make lines-of-code measures from different programming languages comparable.

- **Lines-of-code data are difficult to find.** MGI did not find a data source that tracked the total lines-of-code written by the Business Own-Account or Custom software sectors, or shipped by the Prepackaged software sector; the experts MGI consulted were not aware of any such data existing.

In light of the shortcomings of the hedonic and lines-of-code based measures, FPs seemed the best candidate to serve as the basis for new price indexes.

Constructing a function point-based price index for Business Own-Account and Custom software

MGI was able to find data for a FP-based price index for Business Own-Account and Custom software, but not for Prepackaged software. FP data primarily comes from private researchers who have assembled proprietary databases of projects. These researchers are often paid by companies to make FP counts of a company's projects and to benchmark that count and the cost of the project to other comparable projects from the researcher's database. The end result can be used as a measure of the productivity of the software development process at the company. MGI would like to thank David Longstreet, of Longstreet Consulting, and Capers Jones, of Software Productivity Research, for providing the key data for MGI's new FP-based price index estimates.

Given the process of how FP data are created, there exists sufficient FP data on the average cost of FPs developed in Business Own-Account and Custom software, but limited data on the average cost of a FP delivered to end users by the Prepackaged software sector.

¶ **Business Own-Account software.** In this sector, the total cost of developing code is the same as the price paid for that code. Hence, the estimates of the total cost per FP that were provided to MGI form a strong basis for a price index (Exhibit 8).

¶ **Custom software.** Currently, BEA estimates the Custom software price index by weighting the price decline for Business Own-Account by 75 percent and the price decline for Prepackaged by 25 percent. MGI estimated the Custom software price index as equal to the MGI FP-based price index for Business Own-Account. There are two primary reasons driving this decision:

- Although the majority of the data points that comprised the estimates of total cost per FP were from Business Own-Account projects (approximately 65 percent to 80 percent), the variance in total cost is low between Business Own-Account projects and Custom projects, according to Longstreet Consulting.

- In Business Own-Account, end-user price per FP is the same as total cost per FP. For Custom software, counteracting effects make small the expected difference between end-user price per FP and total cost per FP:

  – *Effects making the end- user price per FP in Custom software slightly higher than in Business Own-Account.* Lower capacity utilization in Custom software would make prices higher for the same work. Custom software workers unfamiliar with their clients face a longer learning curve in setting up and implementing projects. In Custom software, profit margin is added to cost.

  – *Effects making the end-user price per FP in Custom software slightly lower than in Business Own-Account.* Custom software companies face the market's competitive forces more actively. Custom software workers have a potentially greater degree of specialization, allowing for a higher output per hour.

¶ **Prepackaged software.** MGI was unsuccessful in creating an FP-based price index for Prepackaged software due to data availability.

- **MGI could not directly estimate the price per FP for Prepackaged software.** MGI would need data on the number of FPs and average selling price, over time, for a large sample of Prepackaged software applications.

- **MGI could not use the estimates of the cost per FP over time for Prepackaged software.** The logic that total development costs are equal to the end-user's price, which holds true for Business Own-Account software and is expected to be fairly accurate for Custom software, does not hold for Prepackaged software. In the Prepackaged software sector, the number of FPs delivered to end users by the sector is not the same as the number of FPs developed by the sector, since one copy of a developed product can be shipped to many different users. While there are a variety of methods MGI developed that could be used to estimate this scaling effect, sufficient data could not be found with which to make an informed estimate.

- MGI completed an analysis that suggested the end-user price per FP of DOS in 1988, to Windows in 1998, had a CAGR of approximately -11.7 percent. However, MGI did not feel comfortable extrapolating this estimate to the broader sector as it was unclear if it would understate or overstate the overall rate of price decline. BEA's Prepackaged software price index has a CAGR of -9.6 percent over the same period.

THE NEW MGI PRICE INDEXES AND THEIR IMPACT

MGI was able to construct two new sets of price indexes, a base-case scenario and an upper-bound scenario. The MGI base-case price indexes had a very small impact on the delta in labor productivity between 1987-95 and 1995-99. The upper-bound price indexes also had a relatively small impact.

Overall, the conclusion of MGI's software output analysis is that inaccurate measurement of software prices does not significantly impact the delta in economy-wide labor productivity between 1987-95 and 1995-99.

MGI base-case price indexes

MGI created a new FP-based price index that was used for both Business Own-Account and Custom software (Exhibit 9). This index had a CAGR in prices, between 1987 and 1999, of -3.9 percent, versus BEA's +3.0 percent for Business Own-Account software and 0.0 percent for Custom software. The new FP-based price index led to a new overall software sector price index with a CAGR in prices of -5.3 percent, versus BEA's -1.3 percent.

The increase in the resulting overall base-case price index caused a small upward change in the economy-wide labor productivity growth rate (Exhibit 1). The CAGR during the 1987-95 period rose from 1.10 percent to 1.14 percent and, during 1995-99, rose from 1.98 percent to 2.04 percent. The change caused the delta in the rate of labor productivity between the two periods to increase from 0.88 percent to 0.89 percent. With the MGI base-case price index, the delta in the CAGR of labor productivity in the software sector itself decreased from 5.4 percent to 5.0 percent between 1987-95 and 1995-99.

Since hardware only becomes useful by running software, understanding the relative growth rates of the capital stocks of hardware and software can offer insight into the productivity of the assets. From 1987 to 1995, the CAGR in the real capital stock of "computers and peripherals" is 14.1 percent. Over the same period, using BEA prices indexes, the CAGR in the real stock of software is 12.3 percent, while using the MGI base-case price indexes increase the CAGR to 16.8 percent (Exhibit 10). These various figures suggest a close match between the growth in the capital stock of hardware and software between 1987 and 1995. However, over 1995-99, the story shifts, with the real stock of computers and peripherals growing at a CAGR of 42.0 percent, while software grows at 17.1 percent using the BEA price indexes, and 23.1 percent using the MGI base-case price indexes. Between 1995 and 1999, even using the MGI base-case price indexes, the stock of hardware grew much faster than the stock of software, suggesting a risk of a possible slow down in the productivity of hardware capital.

MGI upper-bound price index

MGI wanted to know how much the software sector could affect the aggregate economic growth rate. MGI created an upper-bound price index that combined the most aggressive assumptions about price decline in each of the three sectors that MGI felt were potentially reasonable. Given the new set of assumptions, laid out below, the overall CAGR in prices of the software sector, from 1987 to 1999, would be -10.6 percent. The components, all with constant rates of annual price decline, and all from 1987 to 1999, had CAGRs of -5.5 percent for Business Own-Account, -19.2 percent for Prepackaged, and -9.0 percent for Custom (Exhibit 11).

The resulting overall software upper-bound price index caused a small increase in the delta in the economy-wide labor productivity growth rate, from 0.88 percent for 1987-95 to 0.95 percent for 1995-99. Between the two periods, with the overall software upper-bound price index, the delta in the CAGR of labor productivity in the software sector itself would increase from 5.4 percent to 7.3 percent (Exhibit 11).

Given the low probability of the higher rate of price decline occurring in all three forms of software, and the still limited impact on the economy-wide delta, MGI did not pursue further analysis.

The assumptions used in the new upper-bound index were as follows:

¶ **Business Own-Account software.** MGI had a range of estimates for the rate of price decline, with estimates from Longstreet Consulting at the low end to Software Productivity Research at the high end. As a result, for the upper-bound index, MGI used Software Productivity Research's estimates directly.

¶ **Prepackaged software.** The highest estimate of price decline was the hedonic-based estimate between 1985 and 1993, and this is the estimate used in the upper-bound calculations. While productivity tools have since become a highly concentrated market, during the period measured it was one of the markets with the greatest degrees of competition and scale growth. As a result, the hedonic estimate of -19.2 percent, over the 1985-93 period, becomes an empirically grounded estimate of the upper-bound of the rate of price decline in Prepackaged software.

¶ **Custom software.** BEA estimated the price index of the sector by weighting the Business Own-Account price decline by 75 percent and the Prepackaged price decline by 25 percent. In the MGI base-case price index calculation, a price index was used for Custom software that was 100 percent equal to the Business Own-Account price index. However, for the upper-bound test, that assumption was relaxed, and instead BEA's estimates of 75 percent and 25 percent were used.

Retail and wholesale challenges

STATEMENT OF THE PROBLEM

Two measurement complexities exist in retail and wholesale: a lack of data and problems with the calculation of sales deflators. The lack of available data in retail and wholesale was a major hindrance to our full understanding of the dramatic productivity growth experienced in these sectors. The potential bias introduced by the mismeasurement of the sales deflators is small and unlikely to introduce a meaningful bias in period-to-period comparisons (as the errors are likely to be similar between periods).

MGI'S FINDINGS

Data for retail and wholesale are collected by the Bureau of the Census (Census), the Bureau of Economic Analysis (BEA), and the Bureau of Labor Statistics (BLS).

¶ In retail, these three agencies gather sufficient data to allow both aggregate and subsector analyses of yearly sales data, however, value-added data are only available yearly at the aggregate level and, in Census years, at the subsector level.

¶ In wholesale, none of these three agencies collect a full set of yearly aggregate-level or subsector-level sales data. Value-added data are only available yearly at the aggregate level and not at all at the subsector level. This data situation makes any productivity calculations using solely government data infeasible.

- The Census does not calculate yearly total sales data for this $4 trillion industry. Total sales data are collected only during Census years. However, yearly data is collected, but only for merchant wholesalers.
- The BEA does not calculate value-added data by three-digit SIC code for wholesale, making it impossible to break down the source of the dramatic, measured jump in wholesale productivity growth.

Proper measurement of the sales deflators is very important since the BEA uses them to calculate gross margin deflators, which are ultimately used to deflate nominal value added that is used in the calculation of productivity.

- ¶ There are several measurement issues associated with the retail sales deflator:
  - It is based on the retail CPI, and thus does not adjust for changes in service level within formats (e.g., convenience, location, customer service, length of lines), making real sales an imperfect measure of the output of a retail establishment. Implicitly, the assumption is made that service at a given retailer is proportional to the value of goods offered. The BLS has recently started to calculate hedonic indexes to correct this issue for certain subsegments of retail.
  - It implicitly assumes that price differentials between stores reflect differences in service levels. However, the continuing share gain of low-priced, “big box” formats indicates that service levels at these stores may not be as low as prices suggest.
  - It does not fully take differential rates of inflation between stores (and thus formats) into account due to its use of a multiyear cycle to update the basket.
- ¶ Similarly, there are measurement issues associated with the wholesale sales deflator:
  - It is based on the PPI (producer price index) and therefore does not adjust for wholesale margins to get a true measure of price changes at the wholesale-output level.
  - It uses fixed 1992 weights to calculate three-digit SIC sales deflators and, therefore, it does not adjust for substitution bias as a superlative index would.

IMPLICATIONS

The solution to these problems is well known. The Census would very much like to calculate yearly sales data for wholesale but lacks the funding to do so.

The BLS is currently working on part of the solution relating to sales deflators. It has started to collect gross margin data for parts of the retail sector as well as store characteristics, which will allow them to calculate a hedonic price index for retail.

Calculating a new price index at the wholesale level would clearly solve the problem for this sector, however, this would require rather massive investment on the part of the BLS.

Automotive findings

STATEMENT OF THE PROBLEM

Upon first inspection, the motor vehicle and parts manufacturing industry seemed like a prime example of an "IT paradox"– according to BEA measures, IT intensity growth had accelerated by 8.5 percent since 1995, while real value-added productivity growth had slowed by 0.5 percent. However, MGI's analysis of data available from the Census Bureau's Annual Survey of Manufacturing (ASM) painted a much different picture. As measured by the ASM, real value-added (which does not exclude purchased services) productivity growth appears to have picked up significantly after 1995, from 0.4 percent in 1987-95 to 5.4 percent in 1995-99 (Exhibit 1).

Since definitional differences did not appear to explain this contradiction – the only scope difference is in treatment of purchased services – MGI sought to better understand this discrepancy to determine if the industry was fit to study as a paradox industry. Ultimately, MGI could not develop a productivity measure with a high level of confidence. Additionally, the most convincing productivity measure (ASM) indicated a productivity "jump," leaving motor vehicles unfit to explore as a paradox case.

MGI'S FINDINGS

In the course of exploring the motor vehicle industry, MGI encountered several productivity measurement challenges. Our exploration of those challenges may provide some guidance for future researchers. Specifically, we found that motor vehicle value-added measures may be erroneous due to the BEA's method for constructing nominal value-added measures. The observation that these errors are magnified due to the input-intensity of the auto industry and the approach of our study (looking at productivity acceleration rather than levels or even growth rates) may be applicable to other sectors as well. Finally, the auto industry highlighted the limitation of using output-based productivity measures (rather than value-added); ultimately, MGI was unable to construct an adequate output-based productivity measure due to the high (and increasing) level of within-industry outsourcing.

¶ The only scope difference between BEA's value-added measure and MGI's estimate using ASM data is in the treatment of purchased services. However, the unusual behavior demonstrated by purchased services over this time period leads us to question the BEA value-added estimates. Two methodological details – BEA's method for allocating profit and its practice of combining different data sources – may partially explain this discrepancy.

- BEA calculates nominal intermediate inputs as the difference between nominal gross output and nominal value added. As a result, BEA intermediate inputs are composed of the cost of goods sold (COGS) and purchased services. The ASM, however, measures COGS (but not purchased services) directly. Unfortunately, the behavior of the difference between BEA and ASM measures of intermediate inputs – the implied purchased services – is not realistic (Exhibit 2). McKinsey & Company's Automotive Practice experts understand purchased services to have risen steadily throughout the 1987-99 time period, rather than the steep 1995 compression implied by the BEA and ASM data. Since BEA and ASM output measures are nearly identical, and the ASM COGS estimate is assumed to be reliable (because it is directly measured), MGI inferred that the BEA's intermediate input (which is a direct result of its value-added estimate) estimate must be flawed.

- Conclusively understanding the reasons for value-added estimate shortcomings would require access to confidential firm-specific data. However, two methodological approaches appear particularly suspect:

  – Allocating property-type income (e.g., profits, depreciation) of multi-industry companies based on fixed employment shares could miss significant changes in business segment profitability. Exhibit 3 provides an illustration using actual data from Ford Motor Company, whose primary businesses are auto manufacturing and car rental (through Hertz). The profitability of each of these business segments shifted dramatically between 1989-95 and 1995-99. Since profits were allocated to each industry at a fixed ratio based on employment throughout this time period, auto manufacturing profits were likely overstated in 1995 relative to 1999, understating the value-added jump in this time period.

  – Combining IRS profit income data with BLS labor income data may inadequately capture sharp turns in the components of value added. One contribution to the slowdown in BEA measured value-added growth is the sharp rise, and subsequent fall, in supplemental labor income around 1995. Interviews with BEA staff and industry experts indicate that this was due to auto manufacturers contributing significantly to their previously unfunded pension liabilities. However, we fail to observe a corresponding downward drop in industry profits mirroring this contribution (Exhibit 4). A number of factors could explain why same-year profits might not reflect benefit contribution charges – IRS reporting requirements or firms' individual financing decisions (e.g., funding the contribution through stock or deferring losses) are two such factors. If pension funding was indeed not captured by the industry profit estimate, total net income (value added) would be overstated in 1995, further understating the post-1995 value-added jump.

¶ Value-added productivity measures in the motor vehicle industry were extremely sensitive to these discrepancies. The differences between BEA and ASM estimates of gross output and intermediate input estimates were small to moderate. However, even small discrepancies were greatly magnified when translated to estimates of value added because the industry is so input-intensive. Small changes in either output or intermediate inputs translate into big changes in their difference, value added (exhibit 5). This phenomenon is particularly acute when changes in productivity growth rates (a second derivative) are the object of study.

¶ Lastly, the auto industry highlighted the limitation of using output-based productivity measures (rather than value added). BEA gross output productivity accelerated after 1995. However, an output-based productivity measure would overstate actual productivity improvements because outsourced work is double counted in industry output measures. Indeed, the auto industry did experience an accelerated growth of within-industry outsourcing as more production moved from assembly to components to parts manufacturers (Exhibit 6).

IMPLICATIONS

While the challenges described here impact productivity measurement of the motor vehicle and parts manufacturing sector, the economy-wide measurements remain unaffected. Similar to the Holdings industry discussed previously, however, other sector measurements would be impacted. If value-added growth is understated in the automotive industry, it is likely overstated in other sectors. Our analysis has not illuminated which other sectors may be overstated and to what degree. As a result, MGI has not adjusted its productivity estimates for other sectors in response to these findings.

Further, this exploration has identified several methodological approaches used by the BEA whose results should be interpreted cautiously. Specifically, we may have identified an instance where the BEA's profit allocation methodology and practice of combining different data sources could hamper its ability to estimate value added precisely. Estimate precision was further necessitated by the high level of industry input intensity and MGI's focus on productivity growth acceleration. Future researchers should be aware of the shortcomings of these estimates when a high level of precision is needed.

Communications equipment

STATEMENT OF THE PROBLEM

Over the past decade, communications equipment has seen rapid improvements in performance. For most categories of equipment, capacity has risen much faster than prices. In many ways, this trend is analogous to that in the computer hardware industry, and it builds in part on the same fundamental innovations (e.g. microprocessors).

For computer hardware, the Bureau of Economic Analysis (BEA) attempts to incorporate this trend through the use of a quality-adjusted hedonic price index. However, no such adjustment is made for the improvement in communications equipment performance. The BEA's price index for computer hardware shows a growth rate of approximately -17 percent per year for 1987-99, while the communications equipment price index falls by only 1 percent per year.

MGI FINDINGS

MGI made an estimate of the communications equipment price index using a combination of existing academic studies and expert interviews. A rough approximation yields a price trend of -8 percent per year from 1987 to 1995, -14 percent per year thereafter.

To make its estimate, MGI used official data from the US Census Bureau (Census) to divide communications equipment output and investment into approximately 10 subcategories. Based on interviews and studies, MGI created a price index for each of these subcategories. The overall communications equipment price index is a Fisher ideal price index composed of the separate subcategories.

To generalize somewhat, one can observe three broad price-performance trends in communications equipment, each associated with a different type of hardware:

- **Basic hardware**, which follows a flat price-performance trajectory. For equipment such as fixed-line telephone sets, there is no clear, easily measurable improvement in quality or performance that has taken place over recent years. Therefore, no adjustment was made to available price indices.
- **Electronic and digital systems.** These systems rely on microprocessors and/or digital signal processors, which have seen rapid improvements akin to those in computer hardware. One study by the BEA showed a

price-performance improvement of approximately 9 percent per year for switches, while an unpublished academic study on routers suggested a price-performance improvement of approximately 20 percent per year over the late 1990s.

¶ **Optical transmission systems.** Investment in advanced fiber optics equipment such as SONET (synchronous optical network) and DWDM (digital wave division multiplexing) equipment has increased dramatically in recent years. This equipment uses microprocessors, but has also benefited from innovations in laser/optical technologies. Performance improvements have outstripped even the computer hardware industry, with capacity doubling every 6 to 12 months.

Over time, the mix of these three categories has moved toward more advanced equipment – for example, analog switches have been replaced by digital switches, and optical transmission equipment is moving closer to the "edge" of the network, replacing electrical systems.

IMPLICATIONS

Changing the price index for communications equipment has two impacts beyond the equipment sector.

¶ **Impact on aggregate economic output, labor productivity, and total factor productivity (TFP).** When the price index is adjusted to reflect improved performance, real output of the communications equipment sector grows more rapidly. This in turn increases the aggregate growth of the US economy, improving measured productivity and decreasing TFP (because the capital equipment produced is used by other sectors, and is now greater in value). Drawing on an analysis by Jorgenson and Stiroh, the MGI deflator would increase measured US output growth and labor productivity growth by approximately 0.1 percent per year for 1995-99, with a very slight decrease in TFP growth.

¶ **Impact on the telecommunications services sector**.[11] The telecommunications services sector, not surprisingly, is the biggest user of communications equipment. Using MGI's price index for communications equipment significantly inflates real growth in capital investment for this sector, decreasing TFP growth by several percentage points. (The changed price index does not affect MGI's labor

---

[11] In fact, the change in communications equipment prices affects TFP in all sectors that invest in communications equipment, not just telecommunications services. However, because a large share of communications equipment flows into the telecom services sector, the most dramatic effects are here.

productivity calculations for telecommunications services, since services output is unchanged.)

Experts in the field, including government statistical agencies, are aware of the mismeasurement of communications equipment prices. At a recent Brookings Institution conference on productivity in the communications sector, one conclusion was that in general, telecom services prices are well measured, but telecom equipment prices lack an appropriate adjustment for performance improvement. We hope that government statisticians and academics will soon replace MGI's crude measure with a more detailed analysis of communications equipment prices.

Refining the securities sector's output measure

STATEMENT OF THE PROBLEM

The BEA's gross output measure is based on the revenue data from the income statements of the SEC Focus report, which is the aggregation of filings of all registered brokers and dealers. This methodology created problems in three areas:

- The Focus report covers only the security brokers and dealers/investment banking subsector. To capture the output of portfolio management, which is not covered by the Focus report, BEA extrapolated adjusted Focus report data according to the Census results of benchmark years, i.e., 1987 and 1992. The extrapolations do not accurately reflect the actual economic activities of the portfolio management.
- The BEA used number of trades as the quantity measure for equity trading, which did not take into consideration the different service levels of different trading channels. Brokers provide very different services to different trading channels, ranging from customized investment advice for large institutional investors to bare order execution for on-line day traders. Using a single quantity measure ignored the value of services wrapped into the trades.
- The BEA included the Focus report's "All Other Revenues" in the output, which is mostly the gross interest income from short-term financing activities, and should be cancelled by the corresponding interest expenses.

MGI'S FINDINGS

MGI measured the output of portfolio management by constructing a Fisher quantity index of assets under management of mutual funds, pension funds, and high-net-worth (HNW) accounts. To eliminate the impact of inflation, the GDP deflator is used to adjust the dollar amount of assets under management. To reflect the different service levels of mutual fund, pension funds, and HNW-accounts management, MGI built a price index for each service line based on its average management fee level.

For equity trading, MGI constructed a Fisher quantity index for trading volumes of different trading channels (i.e., wholesale trading, full-service retail trading, discount trading, and on-line trading) to account for the different service levels. We adjusted the public trading volumes on the exchanges from number of trades to number of orders to be consistent with the data from the NASDAQ (one trade is reported on the exchanges if it is a public-to-public trade, however, the same trade represents two orders, one from buyer and another from seller on a dealer market, such as the NASDAQ). MGI used average commission rate of each channel to build a price index. The dealer's spread incomes were allocated as part of the trading cost based on the average size of the trades (number of shares).

MGI excluded "All Other Revenues" from the output measure. This item comprised about 50 percent of the total revenues in the Focus report. Based on our analyses and interviews with industry experts, we estimated that 70 percent to 80 percent of the "All Other Revenues" were the gross interest income from short-term financing activities among brokers, such as repurchase contracts. The actual net interest income is insignificant after taking out the corresponding interest expenses. Moreover, we have already included most business activities, such as M&A, of the remaining 20 to 30 percent revenue in our outputs. Excluding the "All Others Revenues" avoided artificial inflation of the output of the industry and possible double counting.

IMPLICATIONS

The measurement of the securities sector's output has always been murky due to the wide range of services and complex pricing structures offered by the industry. Better measurements of specific services, however, is crucial not only to reflect the performance of the industry more accurately, but also enable detailed analyses on causal factors of productivity performances at subsector level. MGI's measurement improvements allowed us to disaggregate the industry into subsectors, and gain insights on the driving forces of productivity growth. For instance, we discovered that in contrast to the industry in general, portfolio management did not experience a significant productivity jump. We were also able to demonstrate that on-line trading has had less impact than it seemed, since online trades are less valuable than full-service trades.

Refining the depository institutions' output measure

STATEMENT OF THE PROBLEM

To develop a labor productivity measure for retail banking, MGI had to understand BEA's methodology for calculating output for depository institutions, given that more than 85% of employees working in these institutions perform retail banking activities. When further exploring BEA's data, MGI found that BEA's gross output measure for depository institutions is based on the BLS' physical output measure for commercial banks. BLS output measure calculates physical output series for deposit services (payments transactions and time and savings accounts), loans (revolving, non-revolving, real estate and commercial loans), and trusts[12]. MGI found three main issues with the methodology the BLS uses to calculate the output series for commercial banks: The use of labor weights to aggregate the output series, the exclusion or inaccurate measure of some banking products, and the use of the Laspeyeres formula with a fixed-based index as opposed to a chained index.

MGI'S FINDINGS

Use of labor weights to aggregate output time series. The BLS uses labor weights to aggregate commercial banks output time series (deposits services, loans and trusts) because data for revenue weights is not available. Since price for commercial banking services are not transparent it is very complex to develop accurate revenue weight series. To illustrate this case we can think of a balance of US$ 1000 in a savings account. What is the price paid for the interest, services and liquidity the bank provides? Economists have debated about this topic for several decades without reaching consensus. Despite the current debate, most economists would agree that aside from the inherent complexities of calculating prices for banking services, the use of labor weights is inappropriate for the following two reasons:

¶ Labor weights penalize highly efficient outputs. ATM transactions are cost-efficient and provide high convenience. This type of transactions employs limited labor. Conversely, teller withdrawals are highly

---

12 See: " Measuring ouput and labor productivity of commercial banks (SIC 602): a transaction based approach"; Kent Kunze, Mary Jablonski, Mark Sieling.

inefficient, and less convenient, and employ more labor. Under the labor weighting method, teller withdrawals will have higher weight than ATM withdrawals. In other words, a bank with high growth of teller withdrawals will have higher output growth than a bank with high ATM transaction growth.

¶ Labor weights are as difficult to calculate as revenue weights due to the limited data availability. The only source for labor information disaggregated by product is the Functional Cost Analysis Report by the Federal Reserve. This study, which has currently being cancelled, surveyed approximately 50 banks (out of 8,000). The banks surveyed had typically less than 200 employees. Therefore, the data is highly biased to small community banks, and not representative of the sector.

Considering the limitations of using labor weights, MGI developed a model to calculate revenue weights for each of these banking products using the call reports from the Federal Deposit Insurance Corporation (FDIC). MGI's model is based on the opportunity cost[13]. This approach employs a 'reference rate' to determine the portion of banks' income originated from deposits and the portion originated from loans. The reference rate is typically between the average lending rate banks' customers pay for their loans, and the average deposit rate customers received for their deposits. The difference between the reference rate and the rate customers received for their deposits (or the rate paid to a bank in the case of loans) is equal to the price banks charge for their deposit (or loan) services.

There are two significant controversial issues about this methodology. The first one is that sometimes the reference rate may produce negative prices. Unfortunately, there is no much MGI could do about this issue; and fortunately during the period 1987-1999, which is the period MGI analyzed, prices were positive. The second issue is related to the function banks perform. Are banks intermediaries and both deposits and loans are outputs? Or banks receive inputs (deposits) and produce output (loans)? The debate on this topic has not been settled. MGI based on its experience on the retail banking sector and the industry experts it has interviewed believed the industry performs an intermediary function, and hence, deposit functions (payment transactions and long term savings) are considered part of retail banking output measure. Furthermore, for most retail banks deposits services are the largest contributor to banks' revenues and profits.

Exclusion or inaccurate measure of some banking products. BLS measure for transactions does not include information transactions, which in 1999 accounted for 7.5% of total transactions, and debit card transaction, which are 6% of total

---

[13] The user cost approach was first developed by Donovan (1978) and Barnett (1980). Hancock applied this concept to financial services (1985). Fixler and Ziechang (1990) used this approach to develop weights for assets and liabilities. MGI applied the approach Fixler and Ziechang developed to calculate revenue weights for banking physical output series.

transactions. Given that payment transactions contributed to more than 60% of bank's revenues, and that this are two areas that have grown significantly in the last 10 years, BLS is underestimating bank's output growth. Additionally, BLS's estimates for time and savings accounts are calculated assuming all banks offer all type of time and savings accounts. This assumption is not correct, and hence BLS would need to adjust its series using additional data from the American Banker Association.[14]

The use of the Laspeyeres formula with a fixed-based index as opposed to a chained index. This methodology is unique to BLS. A typical Laspereyes index will use the initial basket chained every year to calculated changes in output. BLS uses an initial basket, which is fixed for the next five years. Therefore, it does not use a chain index, but a fixed-weight index. The problem with this methodology is that, when the individual output series are growing at high rates, this method overstates the aggregate output growth rate. Similar, if growth rates of individual output series are decreasing, BLS's method will overstate the decrease rate for the aggregate output.

IMPLICATIONS

Use of labor weights to aggregate output time series. The use of labor weights instead of revenue weights understates labor productivity growth in commercial banks by approximately 0.6% per year from 1987 to 1999. The reason is that revenue weights for deposit services are 67% of total banking revenue[15] and deposits services are growing faster than loans (primarily due to the growth in payment transactions). Labor weights for deposit services are 51%, therefore, by using labor weights, BLS is understating the growth of deposit services and thus, understating commercial output growth.

Exclusion or inaccurate measure of some banking products. To include information transactions and debit card transactions under BLS deposit services will increase labor productivity growth from 1987b to 1999 by 0.6% per year. After improving the measure for time and savings account, BLS's commercial bank output growth will increase by 0.4% per year from 1987 to 1999.

The use of the Laspeyeres formula with a fixed-based index as opposed to a chained index. BLS by using a fixed-based Laspayeres method is overstating by 0.7% per year commercial bank output growth from 1987 to 1999.

---

14 The American Banker Association has developed estimate of the percentage of banks offering each type of time and savings account.

15 Data for 1999.

Holding and other investment offices

STATEMENT OF THE PROBLEM

The measurement of a 42 percent labor productivity acceleration of the "holding and other investment offices" (SIC 67) sector positions it as an extreme outlier compared to the other segments of the US economy. Its dubious productivity profile, characterized by a steep drop from 1987 to 1988 and a rapid rise from 1997 to 1998, prompts questions about potential discontinuities and other complications in the measurement methodology (See Exhibit 1).[16] Simply put, the profile looks too unnatural to be explained by real changes in the economic activity of the sector.

Economists and policymakers, in analyzing the recent productivity acceleration, have noted that a significant portion (e.g., 0.10 percent of the measured 1.33 percent jump measured by MGI) came from this sector. Many recommend increased scrutiny of the effect of this sector on the overall economy, given the high likelihood of measurement inconsistencies and difficulties. Similarly, many analysts at the BEA express concerns about the meaningfulness of measurements in this sector.

It seems clear that few economists feel comfortable drawing conclusions from the 1987-99 "Holding and other investment offices" productivity data. However, no one offers a clear explanation as to why this sector's data should be less reliable than that of other sectors. We sought to explain what might cause the giant swings in productivity growth rates for the sector in order to determine whether it should be considered a meaningful contributor to the 1995-99 productivity growth acceleration.

MGI'S FINDINGS

The plunge in the sector's real value-added productivity from 1987 to 1988 results from the IRS's reclassification of many operating holding companies out of SIC 67 and into other sectors. The BEA uses IRS data to generate GPO (value-added) data, while employment data comes from other sources including the BLS and the Census. In essence, this reclassification resulted in a substantial drop in the

---

16 There are two lines before 1987 as we attempted to account for a methodology change occurring in 1987. This analysis does not impact the measurement of the 1987-1999 sector productivity, but rather was done to ensure that 1987 data was indeed unaffected by the methodology change.

measured output of the sector without a corresponding drop in the sector's employment – hence the unnatural crash in labor productivity levels.

¶ The "holding and other investment companies" sector, defined by the IRS, is primarily composed of "real estate investment trusts" (REITs), "regulated investment companies" (RICs), and "other holding and investment companies (except bank holding companies)."

- The RIC category is composed primarily of mutual funds, and accounts for the vast majority (approximately 95 percent) of the sector's receipts less deductions.

- The holding companies included in "other holding and investment companies (except bank holding companies)" are defined roughly as companies whose primary receipts are interest, dividends, and capital gains. Hence, the intention is to capture the value added by "pure" holding companies, rather than by operating companies (which also report substantial operating revenues).

¶ Disaggregating the productivity calculations, it is clear that the 1987-88 drop is the result of a 67 percent decrease in nominal value added (72 percent in real value added).

- The BEA calculates nominal value added for the sector by adding up profit before taxes, net interest, compensation, depreciation, indirect business taxes, and business transfer payments[17].

- Employment maintains a steady growth over the period of approximately 6 percent, in line with subsequent years.

¶ Beginning in 1987, the IRS, noting significant growth in holding companies with business receipts in the sector, reclassified a significant number of these operating holding companies out of the sector (and into a wide variety of other sectors including utilities and manufacturing). This increased scrutiny continued through 1991, when an electronic classification system applied a more consistent set of criteria for inclusion in "holding and other investment companies." Though the reclassification occurred through 1991, the drop in operating profit, or business receipts less cost of goods and services, was most substantial from 1987 to 1988. This drop (of about $10 billion) presumably drove the actual 1987-88 plunge in the BEA's measurement of the sum of profit before taxes and net interest (Exhibit 2).

---

17 The BEA handles corporations and non-corporations (sole proprietors and partnerships) slightly differently and for some statistics, aggregates them separately. Though there is evidence of a drop in measured value added in both types of companies, we were only able to address corporations in detail, as far more information was publicly available about the methodology and data for corporations than for non-corporations.

- While it is difficult to isolate the exact mechanical cause of the drop in profit before taxes and net interest, one very clearly notes a marked departure of measured economic activity from the sector initiating in 1987. Most obviously, the sectors' business receipts (the IRS' term for operating revenues) decrease rapidly from a 1987 level of approximately $80 billion to a 1991 level of approximately $15 billion.

- Costs of goods and services (the IRS's term for COGS, purchased services, and a small portion of salaries) also plunged throughout this period, from approximately $50 billion in 1987 to $10 billion by 1991.

- Both business receipts and costs of goods and services are embedded within the sum of profit before taxes and net interest.

¶ It has been particularly difficult for economists and statisticians to locate this source of error given both the particularly small percentage of business receipts relative to total receipts as well as the diversity of the economic activity in the sector.

- Companies in this sector are holding and investments companies and thus, have a far greater amount of capital gains, interest, and dividends receipts than business receipts. Movements in the other categories drowned out the drop in business receipts. However, as the sum of profit before taxes and net interest excludes non-operating revenues (such as capital gains, interest, and dividends), the drop in business receipts becomes particularly significant.

- Due to the "pass through" nature of many of these investment receipts, this sector has a tremendous number of total receipts less deductions – accounting for about 25 percent of those of the total economy.

- This sector includes a wide variety of different types of economic activity from mutual funds to oil royalty traders to patent owners and lessors. Given these sectors all have different IRS filing rules and are impacted differently by various economic factors and regulatory changes, it is quite difficult to link the sector's performance to macroeconomic trends.

Though we could not find as compelling an explanation for the 1997-98 productivity jump, we hypothesize that it also results from a reclassification – that involved in mapping the 1987 SIC (Standard Industrial Classification) codes to the more recently developed NAICS (North American Industrial Classification System) codes.

¶ There are many indications that the 1997-98 jump results from a reclassification, similar to that occurring in the first period.

- The jump results from an unnaturally rapid surge in nominal value added – a 376 percent jump (331 percent in real dollars).
- After the jump, the relatively high productivity level holds steady.[18]
- The timing of the movements of value added in the late 1990s does not correspond with that of major economic trends, such as venture capital returns or market value appreciation.

¶ The IRS defined its sectors such that they are comparable to the definitions in the SIC system ("holding and other investment companies," for example, corresponds to SIC 67). This allows the IRS to aggregate companies' returns based on their SIC code (several exceptions do exist) and then to pass on this data to other organizations, including the BEA. However, in 1998, the IRS changed its tax forms such that it collected companies' NAICS codes, rather than their SIC codes. However, to ensure that 1998 data could be compared to 1997 data, the IRS mapped the NAICS classifications to the SIC classifications – this allowed them to report the data in the identical categories as previously, though it introduced a small degree of error to all sectors (other than those SICs unchanged by the NAICS system). Given the particularly small size of the "holding and other investment companies sector," though, this error proved significant (See Exhibit 3).

- Comparing the NAICS and SIC systems, it is clear that the mapping from NAICS to SIC 67 (Holding and other investment companies) is non-trivial.
- In particular, this process requires apportioning a certain percentage of several categories' total receipts to SIC 67 – at best an approximation of the old categorization process.

IMPLICATIONS

While the reclassification occurring from 1987 to 1991 and the potential problems introduced by the mapping from NAICS to SIC codes would impact the productivity measurements for the "holding and other investment companies" sector, the economy-wide measurements would remain unaffected. Other sector measurements would be impacted, however, as the artificial value added and productivity jump in "Holding and other investment companies" would appear as

[18] The 2000 data will be useful in verifying this hypothesis as a reclassification would suggest that the productivity level for this set of economic activity should remain at, or close to, this "new" higher level.

artificial declines in other sectors. Given that the reclassifications would allocate companies into a wide variety of larger sectors, though, this would presumably not have a significant effect on any other individual sector. Hence, the importance of this finding is that it would cause researchers to remove the “holding and other investment companies” from their sector-level productivity analyses, at least for studies using statistics prior to 1998. As such, MGI does not study the “holding and other investment companies” productivity jump as a key to understanding the causation and sustainability of the recent acceleration.

Further, though these reclassifications create problems in comparing the sector’s data over time, we do not wish to imply that the adjustments were made without justification. In fact, the IRS’s decision to reclassify operating holding companies out of the sector and then to streamline the classification process had the positive effect of tightening the range of economic activities within the sector. In addition, though there are also many disadvantages posed by the process of switching to the NAICS system, one positive implication is the separation of holding companies from other investment companies such as mutual funds. Ultimately, when all the governmental agencies update to the NAICS system, trends within the sector previously defined as “Holding and other investment companies” will be more transparent.

CONFIDENTIAL

Exhibits for Software Vertical Document

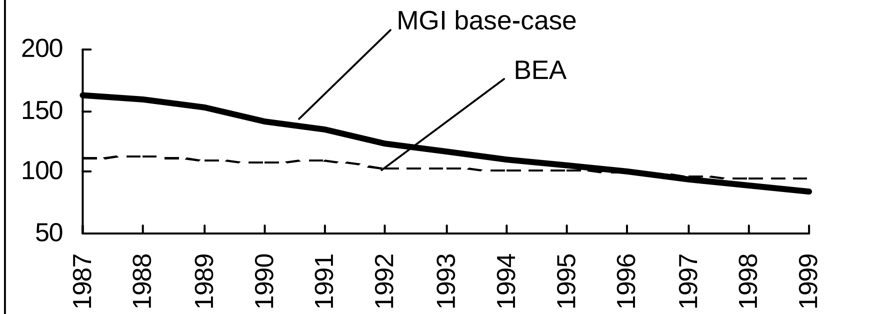
McKINSEY GLOBAL INSTITUTE

June 15, 2001

Exhibit 1

SUMMARY RESULTS

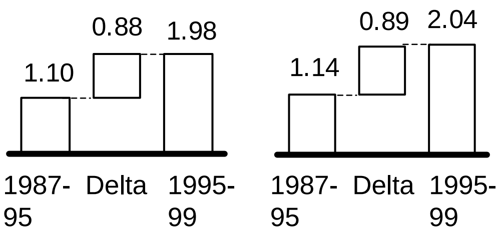
Overall software price indexes (1996 = 100)



	Price indexes			CAGR (percent)		
	1987	1995	1999	1987-99	1987-95	1995-99
BEA	112	102	96	-1.3	-1.2	-1.6
MGI base-case	163	105	85	-5.3	-5.1	-5.3

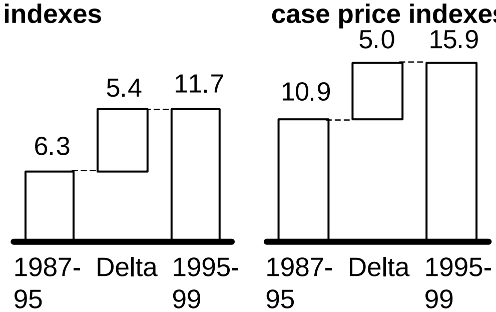
Economy-wide average labor productivity
CAGR, percent

Using BEA price indexes | **Using MGI base-case price indexes**



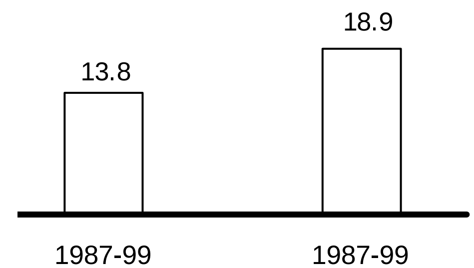
Average labor productivity in software
CAGR, percent

Using BEA price indexes | **Using MGI base-case price indexes**



Real capital stock of software
CAGR, percent

Using BEA price indexes | **Using MGI base-case price indexes**

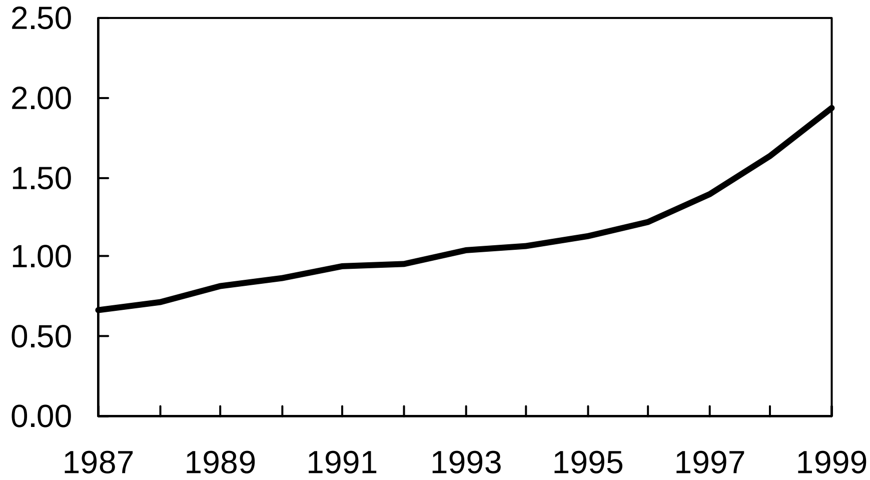


Note: Numbers may not add due to rounding

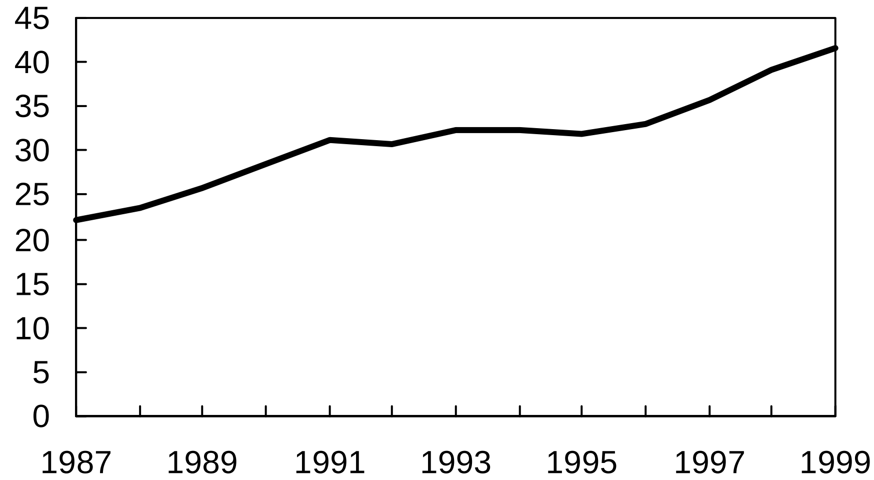
Exhibit 2

GROWTH IN THE SOFTWARE SECTOR IN PERSPECTIVE

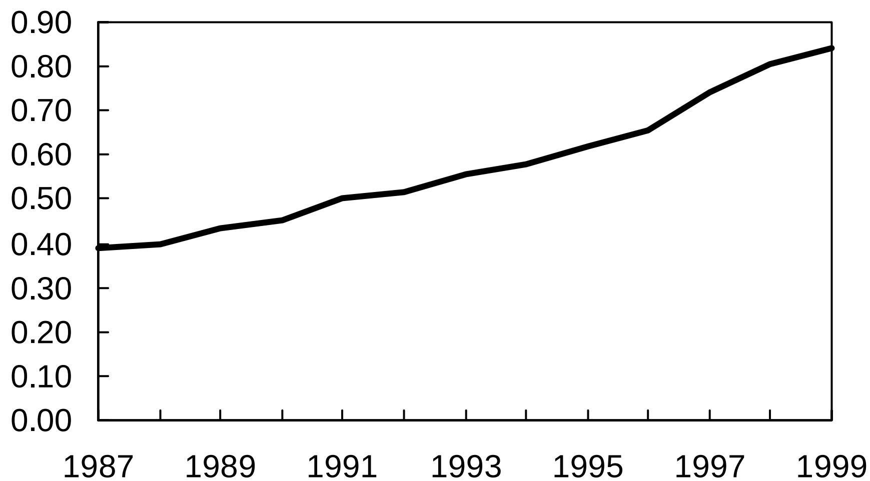
Current dollar software investment as a percent of GDP



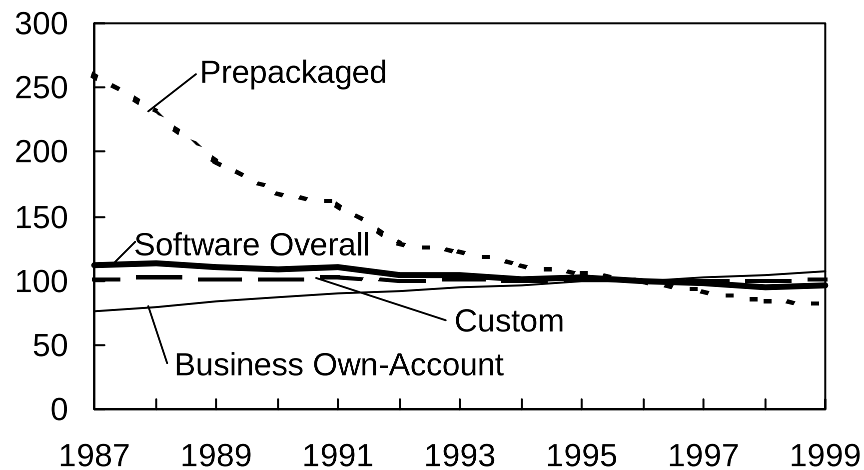
Current dollar software investment as a percent of IT spending*



Software as a percent of US employment**



BEA price indexes, 1996 = 100



* Defined as a percentage of the BEA category "Private Fixed Investment in Equipment and Software," which includes telecom equipment

** Defined as a percentage of the number of Persons Engaged in Production (PEP)

Source: BEA

Exhibit 3

DETAILS OF HOW BEA ESTIMATES THE PREPACKAGED PRICE INDEX

Percent

Overview

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Annual measured price decline	-12.8	-6.0	-11.0	-16.7	-12.8	-4.9	-19.8	-4.7	-8.6	-5.4	-5.7	-8.4	-8.1

- 1986–1993: Calculated by combining hedonic index and matched model index by equal weighting. CAGR: -11.2 %
- 1994–1997: Uses matched model approach; makes a bias adjustment up of 3.15%, based on the expected bias in the matched model extrapolating from 1986-93. CAGR: -6.5 %
- 1998: Uses BLS PPI, with same 3.15% bias adjustment. CAGR: -8.1 %

Detail[1]

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Hedonic	-15.0	-9.6	-21.2	-31.3	-22.7	-10.2	-31.9	-7.5	–	–	–	–	–
Matched model	-10.7	-2.3	-0.9	-2.1	-2.9	0.4	-7.8	-2.0	-5.4	-2.2	-2.5	-5.2	-5.0
Price index for computers and peripherals	-13.9	-14.8	-7.1	-6.6	-9.3	-10.2	-14.5	-14.7	-11.8	-16.5	-23.8	-22.5	-26.0

1986–1993:

- Hedonic index: BEA developed hedonic price indexes for 2 types of prepackaged software – spreadsheets and word processing.[2] Price index estimates are based on regressions in which the logarithm of prices of prepackaged software is a function of selected quality characteristics and of dummy variables for each year of the price observations. The resulting indexes are "regression" price indexes in which the coefficients of the dummy variables for each year are used to construct price index values for the sample periods of the regressions[3]
- Matched model: formulated based on matched indexes for spreadsheet and word processing programs developed by Steven Oliner and Daniel Sichel
- The equal weighting average is used, over the hedonic index alone, due to the concern that the hedonic index may overstate price declines over time, with the characteristics of high-price packages with limited sales incorporated into lower-price packages that have much greater sales. (This sampling bias gives too great a weight to the values derived from the high-priced packages.)

1994–1997:

- Hedonic index: data insufficient after 1993
- Matched model: uses private source data on retail prices and quantities sold of selected types of prepackaged software including spreadsheets, databases, and word processors[4]
- Bias adjustment: it is likely that the matched-model indexes understate quality-adjusted price declines; quality improvements tend to be introduced in new upgrades of software, so they are not captured by the matched-model estimates

1998:

- The BLS PPI is based on all applications software.[5] The BLS index is linked to a monthly version of the BEA-matched model price index in December 1997

Prepackaged software index prior to 1985

- Calculated by determining the ratio of the software deflator index to the computer deflator index over 1986-97. Applies the ratio to the historical computer index data, to extend the software index back to 1959
  – **Detail**: The ratio applied is 60%. This percentage corresponds to the average difference for 1985-97 in the annual rates of change in the computer and peripherals price index and the annual rates of change in the prepackaged software price index

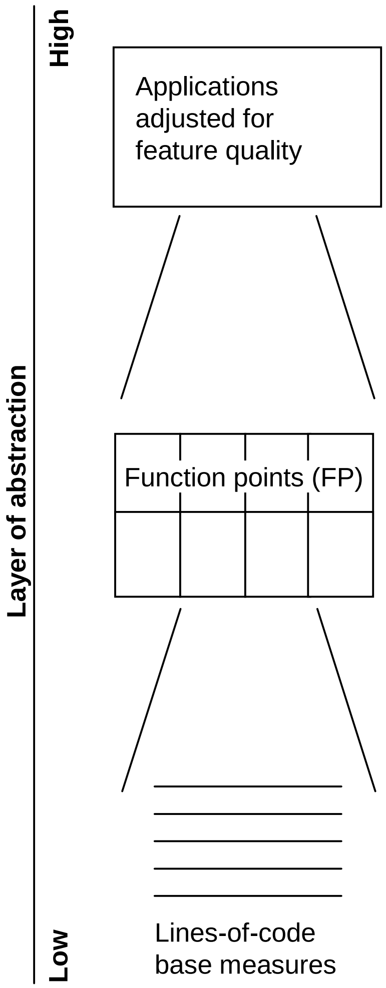
1 Section closely paraphrases BEA text from the source document
2 Data on prices and quality characteristics from the National Software Testing Laboratories
3 Hedonic price indexes are estimated using a methodology that is an extension of earlier work on software prices by Brynjolfsson and Kemerer and by Gandal
4 Extends the Oliner-Sichel matched-model index to 1997 and is based on a broader group of business-oriented Prepackaged programs
5 Exact range of Prepackaged software covered is not clear

Source: BEA paper, “Recognition of Business and Government Expenditures for Software as Investment: Methodology and Quantitative Impacts, 1959-98”

Exhibit 4

OPTIONS FOR MEASURING SOFTWARE OUTPUT

Approach chosen



Definition of output	Potential approaches	Evaluation
Applications, adjusted according to the perceived quality of the feature set	• Generate new price index using a broad range of applications **and/or** • Find "general" set of valued attributes in software products, and use product scores in categories to create hedonic index	• Insufficient data available to expand existing hedonic calculations • Hard to define generic measures for functionality across all products, and limited data for evaluation of products, particularly across time
Total number of function points (FP) shipped. A FP count measures the data manipulation capacity of a piece of software	• Deduce total FP output based on estimates of production cost of FPs over time **and/or** • Directly measure total number of FPs shipped	• Promising approach for Custom and Business Own-Account software since it is reasonably objective and data is available • Insufficient data
Total source code shipped	• Measure directly or estimate	• Least correlation with functionality • Limited data

Exhibit 5

OVERVIEW OF FUNCTION POINT CALCULATING METHODOLOGY

Unadjusted FP count =
(sum of number of transactions, with each transaction weighted by how much data it manipulates)
+
(sum of number data organization tables, with each table weighted by how much data it enables the manipulation of)

Transaction types	Amount of data manipulation in transactions, calculated on
• Inputs to software • Simple inquiries into software for data • Outputs of software (calculated results, etc.)	• Number and type of reference tables accessed • Number of data elements accessed in each table

Table types	Data manipulation rating based on
• Table in application • Table outside application	• Number of unique data types • Number of unique record types

Adjusted FP count = (unadjusted FP count) x (value adjustment factor)

Value adjustment factor

- Ranges from 0.65 to 1.35
- Calculated based on overall program's score on 14 variables:

– Data communications	– On-line update
– Distributed data processing	– Complex processing
– Performance	– Reusability
– Heavily used configuration	– Installation ease
– Transaction rate	– Operational ease
– On-line data entry	– Multiple sites
– End user efficiency	– Facilitate change

Equivalent to rating a house's square footage higher if the house offers

- Heating
- Plumbing
- Overhead lighting
- etc.

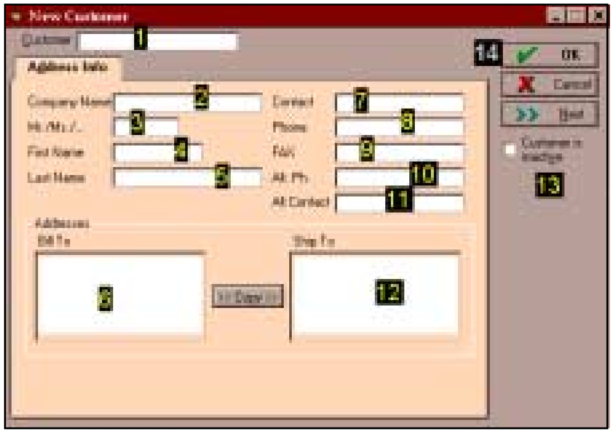
Source: Longstreet Consulting

Exhibit 6

SAMPLE FP COUNTS

Sample "transaction"

An example "input dialog box"; showing 13 data elements, and 1 transaction button (#14). Data is put into 1 table.



Number of tables referenced	Data elements 1-5	6-19	>19
0-1	Low	Low	Average
2-3	Low	Average	High
>3	Average	High	High

Rating	Transaction Types: Input	Inquiry	Output
Low	3	3	4
Average	4	4	5
High	6	6	7

3 unadjusted FPs are added to the application's count

<u>Sample "data organization table"</u>

Data elements, # = 6   Record types, = 2

1 Artist	2 Album name	3 Publication date
Bruce Springsteen	Born to Run	1978
Phil Collins	Hits	1998

Songs

4	5	6
1.	Born to Run	(4:30)
2.	Thunder Road	(4:48)
3.	Bad Lands	(4:02)
4.	River	(5:00)
5.	Hungry Heart	(3:20)
6.	Atlantic City	(3:56)
7.	Dancing in the Dark	(4:03)
8.	Born in the USA	(4:41)
9.	My Hometown	(4:12)
10.	Glory Days	(3:49)

Record types	Data elements 1-19	20-50	>50
1	Low	Low	Average
2-5	Low	Average	High
>5	Average	High	High

Rating	Table Type: Internal table	External table
Low	7	5
Average	10	7
High	15	10

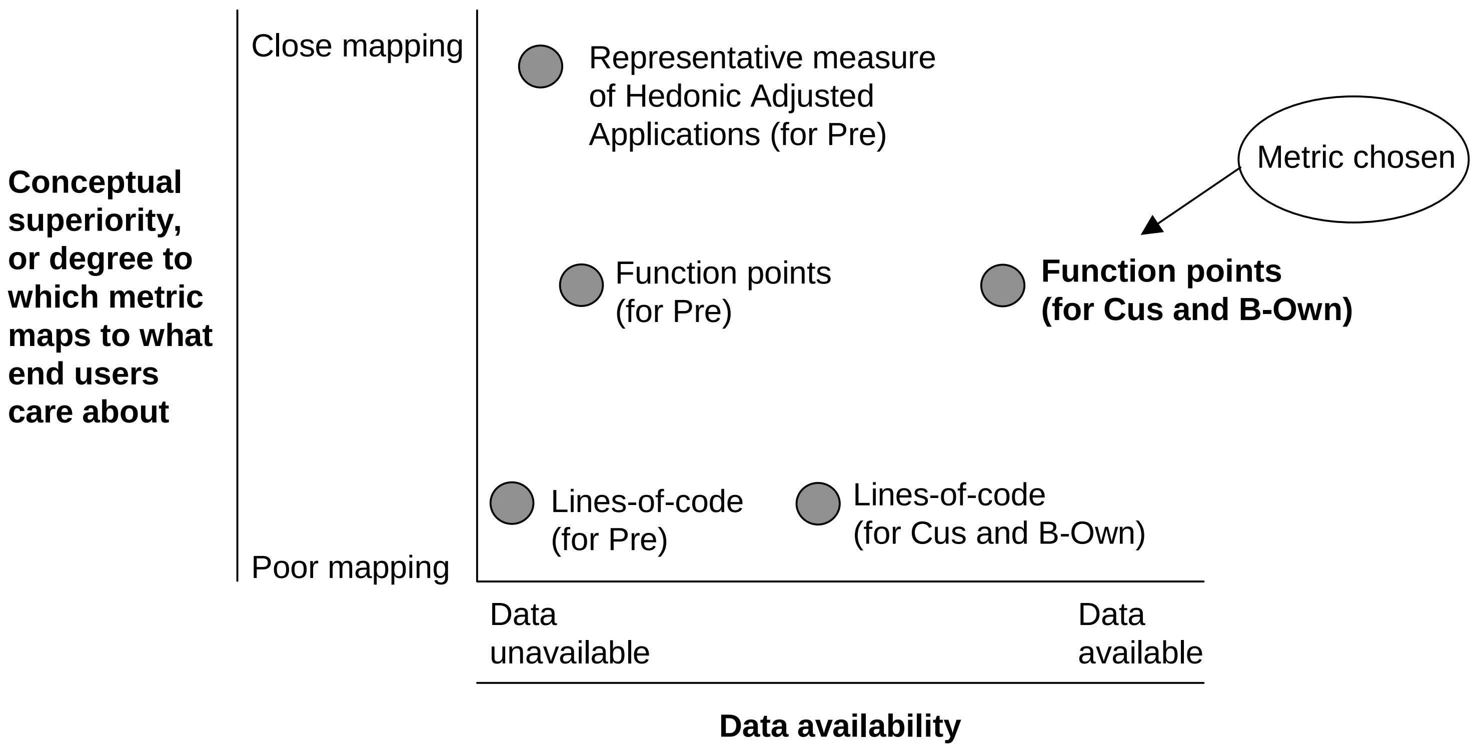
7 unadjusted FPs are added to the application's count

Source: Longstreet Consulting

Exhibit 7

UNDERSTANDING WHY FUNCTION POINTS WERE CHOSEN AS A MEASURE OF OUTPUT

Pre = Prepackaged software
Cus = Custom software
B-Own = Business Own-Account software



Source: MGI analysis

Exhibit 8

CALCULATIONS FOR BUSINESS OWN-ACCOUNT AND CUSTOM SOFTWARE PRICE INDEX

			1985	1990	1995	2000
Step 1	Estimate from Software Productivity Research	FP price index, 2000=100:	216	204	137	100
		CAGR:		-1.1%	-7.6%	-6.2%
	Estimate from Longstreet Consulting	FP price index, 2000=100:	129	127	117	100
		CAGR:		0.2%	-1.6%	-3.1%
Step 2	Average CAGR			-0.4%	-4.6%	-4.6%

		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Step 3	CAGR during year assumed		-0.5%	-0.5%	-0.5%	-4.6%	-4.6%	-4.6%	-4.6%	-4.6%	-4.6%	-4.6%	-4.6%	-4.6%
Final	Resulting price index, 1996 = 100	140	140	139	130	127	121	115	110	105	100	95	91	87

Note: David Longstreet, of Longstreet Consulting, suggested that the difference between the estimates comes from Software Productivity Research averaging across projects equally, while Longstreet Consulting's estimates weight the cost per FP from different projects by the size of the projects

Source: Software Productivity Research; Longstreet Consulting; McKinsey analysis

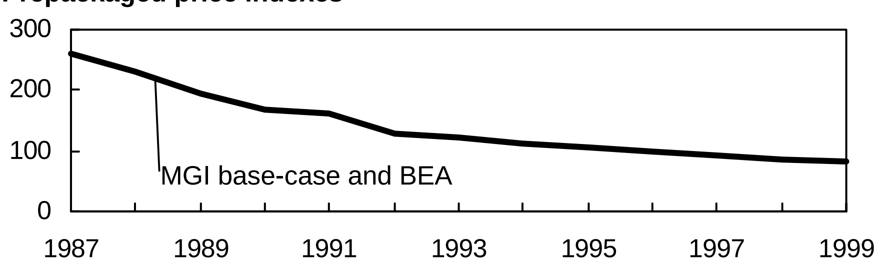
Exhibit 9

SUMMARY OF BASE-CASE PRICE INDEXES

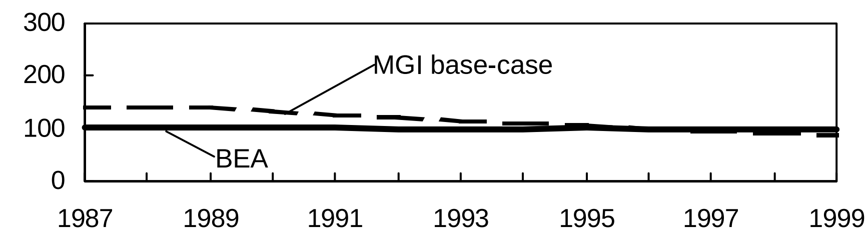
Dollars

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	CAGR 1987-99 Percent	CAGR 1987-95 Percent	CAGR 1995-99 Percent
BEA price indexes, 1996 = 100																
• Prepackaged	261	232	193	169	160	129	122	112	106	100	91	84	82	-9.2	-10.6	-6.2
• Custom	101	103	102	102	103	100	101	100	101	100	100	99	100	0	0	-0.1
• Business Own-Account	75	80	83	87	90	92	95	96	99	100	103	104	107	3.0	3.5	1.9
• Software overall	112	114	111	109	110	104	104	102	102	100	98	95	96	-1.3	-1.2	-1.6
MGI base-case price indexes, 1996 = 100																
• Prepackaged	261	232	193	159	160	129	122	112	106	100	91	84	82	-9.2	-10.6	-6.2
• Custom	140	140	139	133	127	121	115	110	105	100	95	91	87	-3.9	-3.6	-4.6
• Business Own-Account	140	140	139	133	127	121	115	110	105	100	95	91	87	-3.9	-3.6	-4.6
• Software overall	163	159	152	142	135	123	117	111	105	100	94	89	85	-5.3	-5.3	-5.1

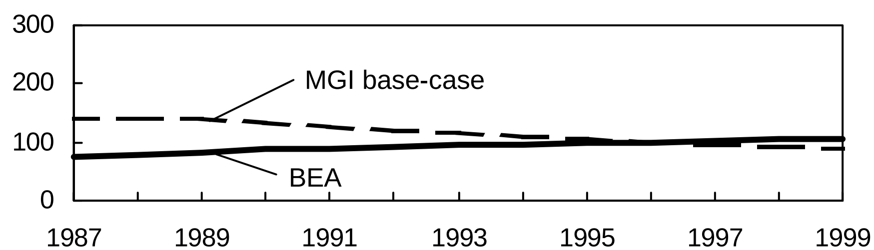
Prepackaged price indexes



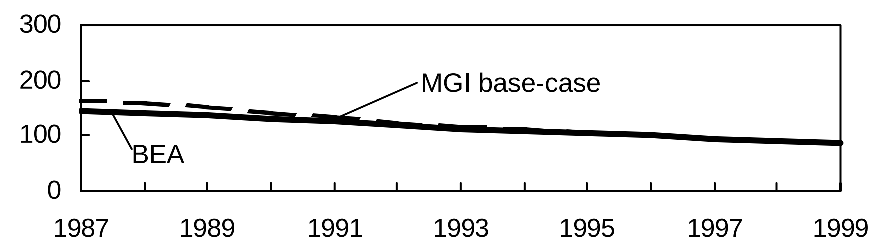
Custom price indexes



Business Own-Account price indexes



Software overall price indexes



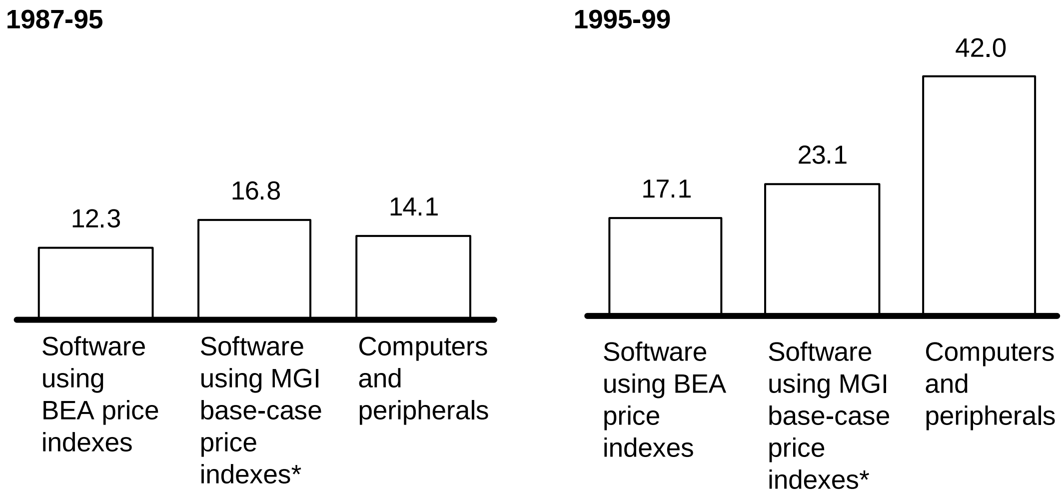
Source: BEA; Software Productivity Research; Longstreet Consulting; McKinsey analysis

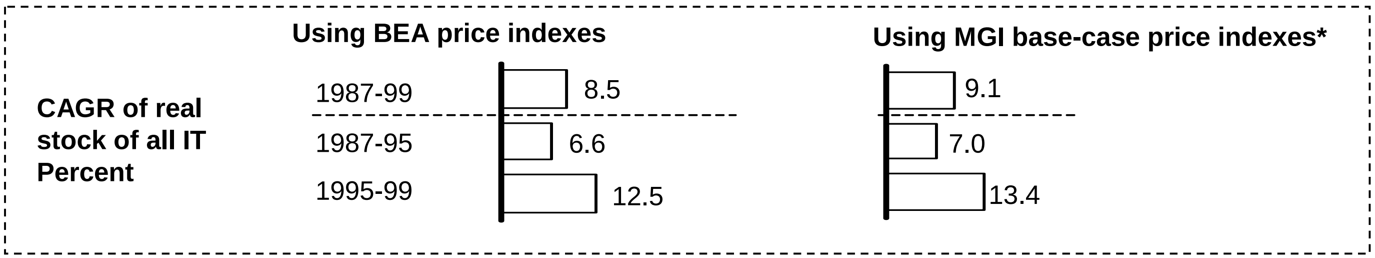
Exhibit 10

IMPACT OF MGI BASE-CASE PRICE INDEXES ON THE GROWTH RATE IN THE REAL CAPITAL STOCK OF SOFTWARE

CAGR of real capital stock

Percent





* The increase due to the new MGI price indexes is initially calculated using intermediate-level GDP expenditure data, but is then calibrated using the expected deviation from the result that would be obtained from calculating a Fischer Ideal index on the most detailed-level data, based on the deviation found from using intermediate-level data and the BEA price indexes, compared to the BEA's official results

Note: Over 1987 to 1999, the CAGR in the real capital stock of computers and peripherals is 22.8%, for software using the BEA price indexes it is 13.8%, and using the MGI base-case price indexes it is 18.9%

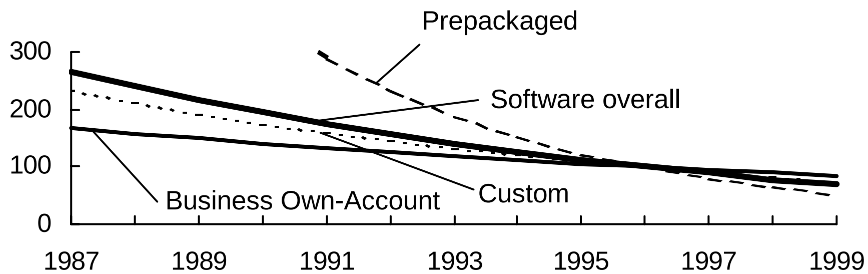
Source: BEA; MGI analysis

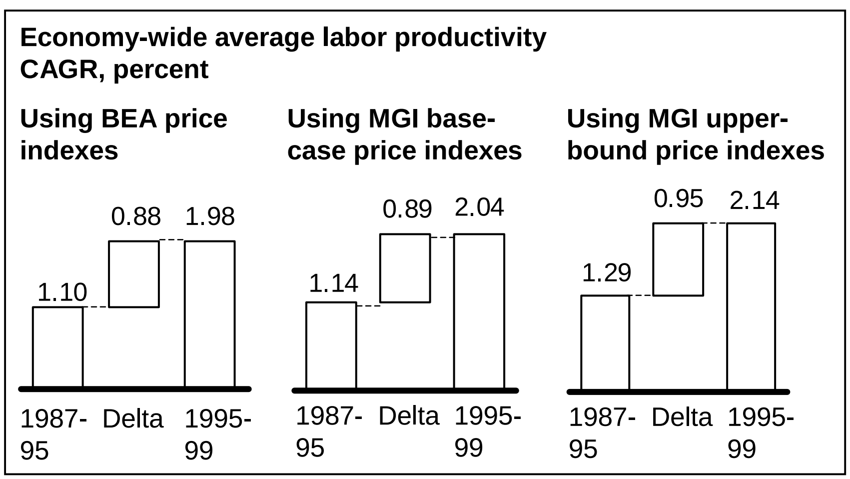
Exhibit 11

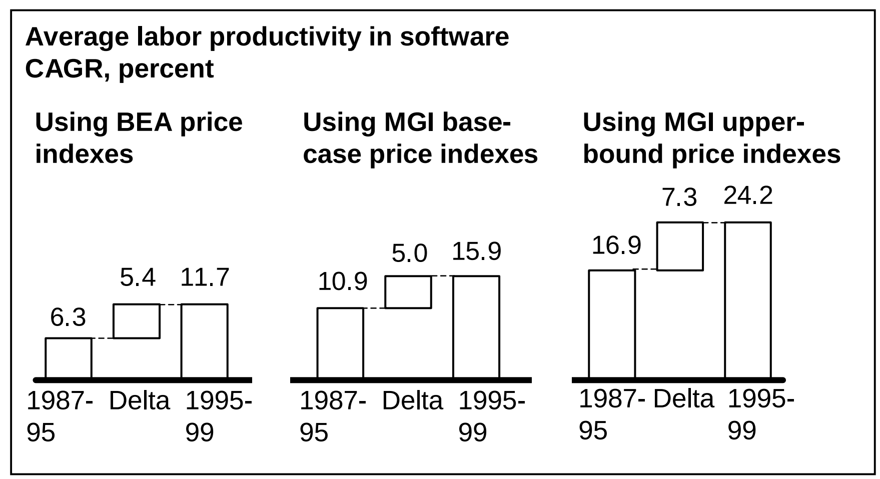
MGI UPPER-BOUND PRICE INDEXES

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	CAGR, percent 1987-99	1987-95	1995-99
Upper-bound MGI price indexes, 1996 = 100																
• Prepackaged	681	550	445	359	290	235	190	153	124	100	81	65	53	-19.2	-19.2	-19.2
• Custom	233	212	193	176	160	146	132	121	110	100	91	83	75	-9.0	-9.0	-9.0
• Business Own-Account	167	158	149	141	133	126	119	112	106	100	94	89	84	-5.5	-5.5	-5.5
• Software Overall	266	241	217	195	175	157	141	126	112	100	89	78	69	-10.6	-10.2	-11.5

Price indexes







Note: Numbers may not add due to rounding

Source: BEA; Software Productivity Research

CONFIDENTIAL

Motor Vehicle Manufacturing

MGI/HIGH TECH NEW ECONOMY PROJECT

September, 2001

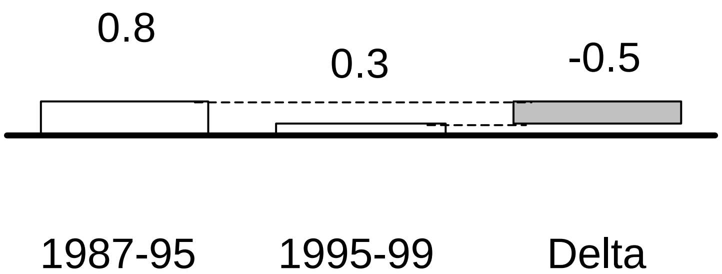
Exhibit 1

BEA ESTIMATES A DECELERATION IN VALUE-ADDED PRODUCTIVITY IN MOTOR VEHICLE MANUFACTURING; CENSUS DATA IMPLIES OTHERWISE

CAGR, percent

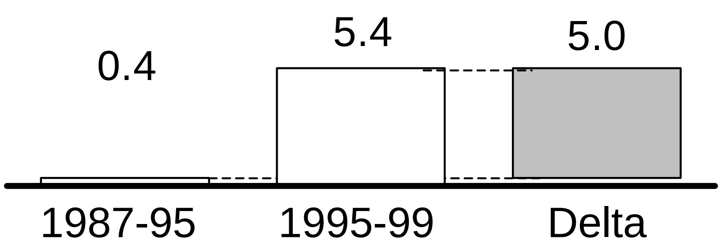
BEA

Real value added per PEP



Census

Real value added per hour

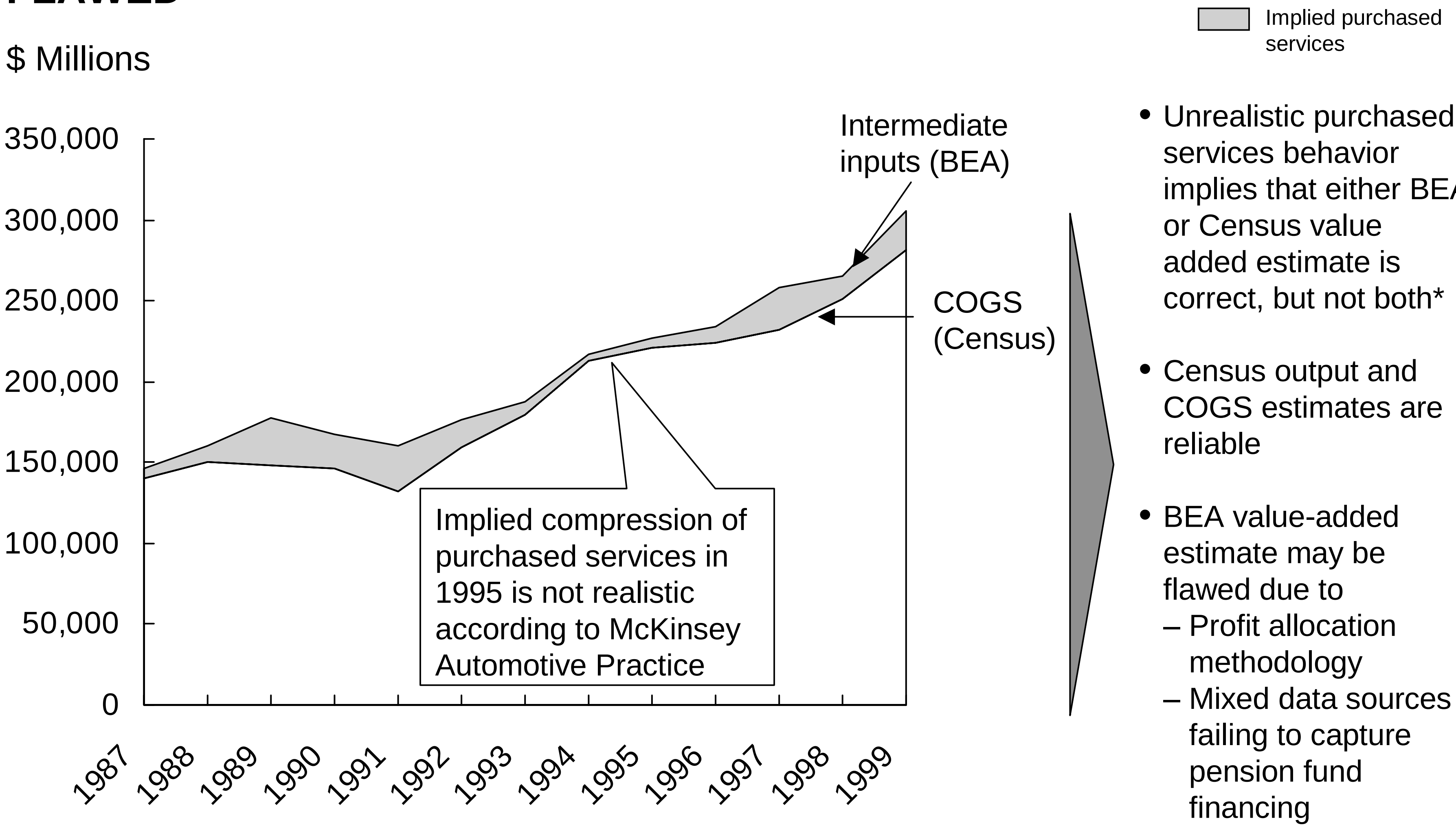


- Value added productivity measures are very different, leading to uncertainty about the nature of the case
- Output and employment measures are nearly identical
- Only definitional difference between estimates is in treatment of purchased services
  - BEA excludes purchased services from value added
  - Census includes purchased services in value added

Source:Census Bureau Annual Survey of Manufacturers; BEA; MGI analysis

Exhibit 2

UNUSUAL IMPLIED PURCHASED SERVICES BEHAVIOR SUGGESTS THAT BEA VALUE-ADDED ESTIMATES MAY BE FLAWED



- Unrealistic purchased services behavior implies that either BEA or Census value added estimate is correct, but not both*
- Census output and COGS estimates are reliable
- BEA value-added estimate may be flawed due to
  – Profit allocation methodology
  – Mixed data sources failing to capture pension fund financing

* BEA estimates intermediate inputs as the residual between measured gross output and measured value added

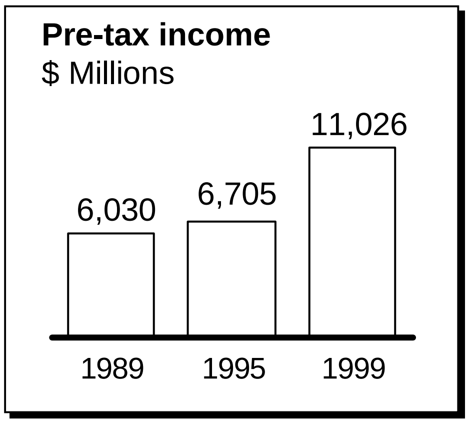
Source: BEA, 1997-99 Annual Survey of Manufacturing; McKinsey Automotive Practice; MGI analysis

Exhibit 3

PROFIT ALLOCATION MAY UNDERSTATE ACCELERATION IN AUTO MANUFACTURING VALUE ADDED

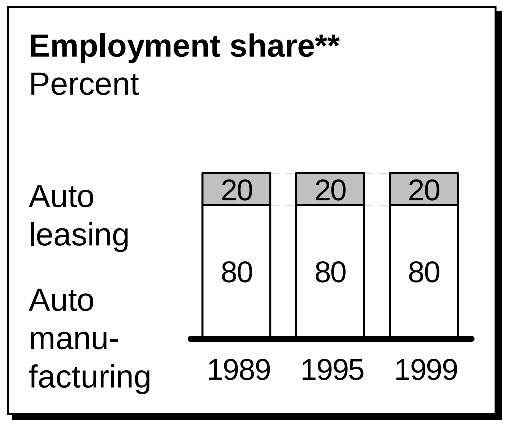
ILLUSTRATION OF FORD MOTOR COMPANY

If total profits for entire company (auto leasing and manufacturing) . . .

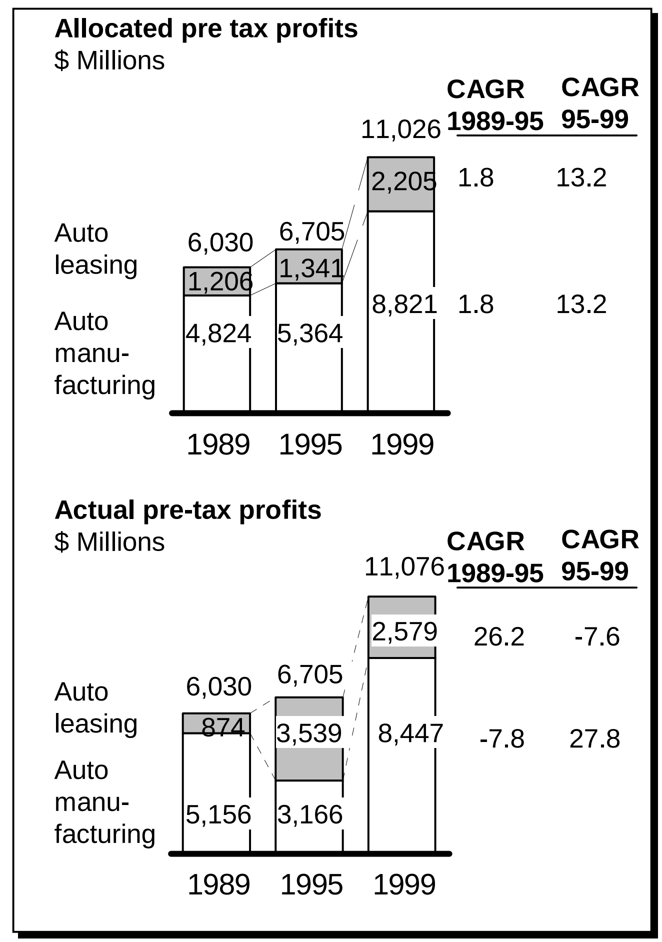


X

. . . are allocated based on constant employment share*, . . .



. . . then profits can be misallocated if employment share or profit per employee by segment changes over time



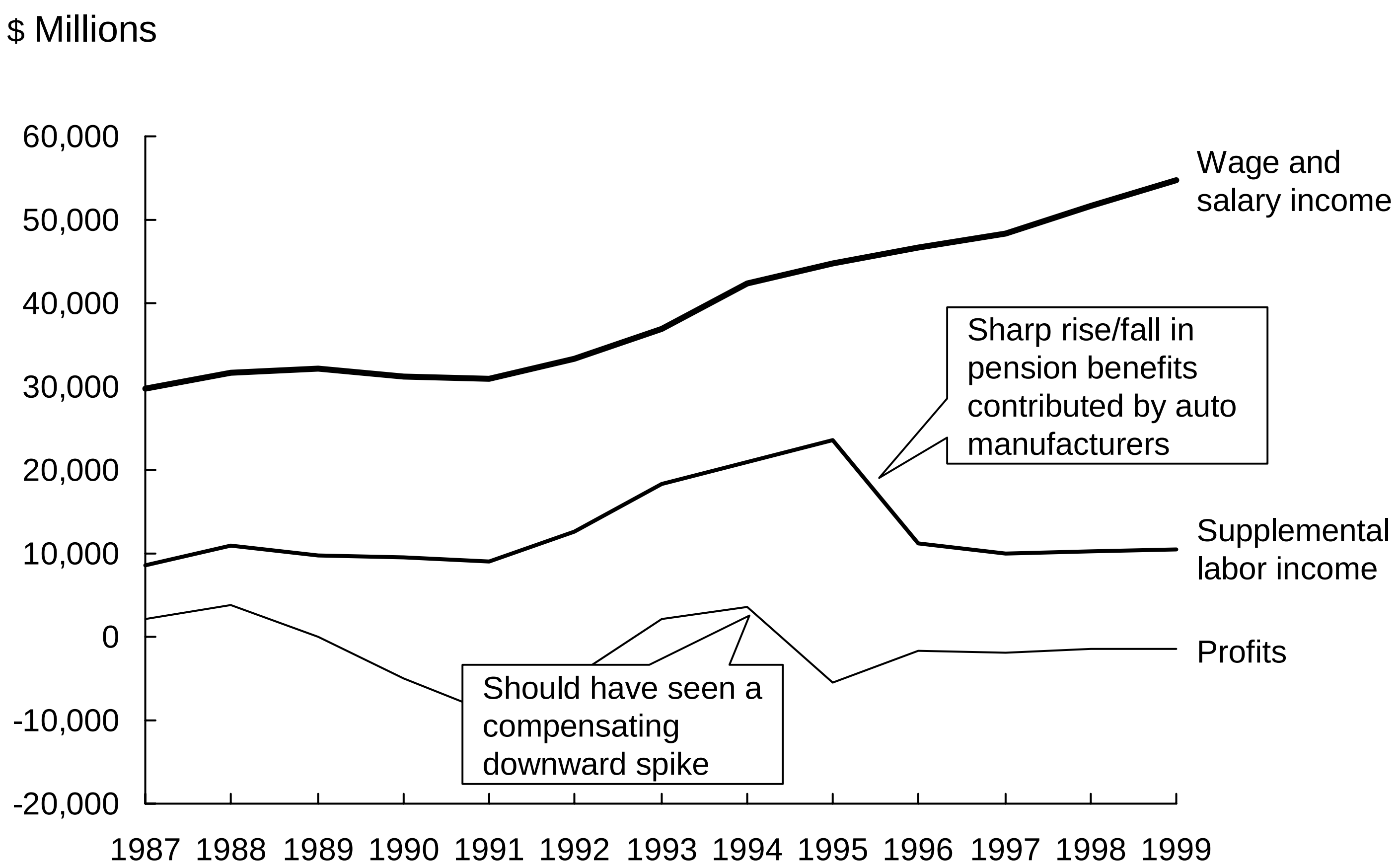
* The company-industry-employment matrix used for allocating profits uses 1992 Census employment composition for all years after 1992

** Not actual employment share data

Source: BEA interviews; Ford Motor Company annual reports; MGI analysis

Exhibit 4

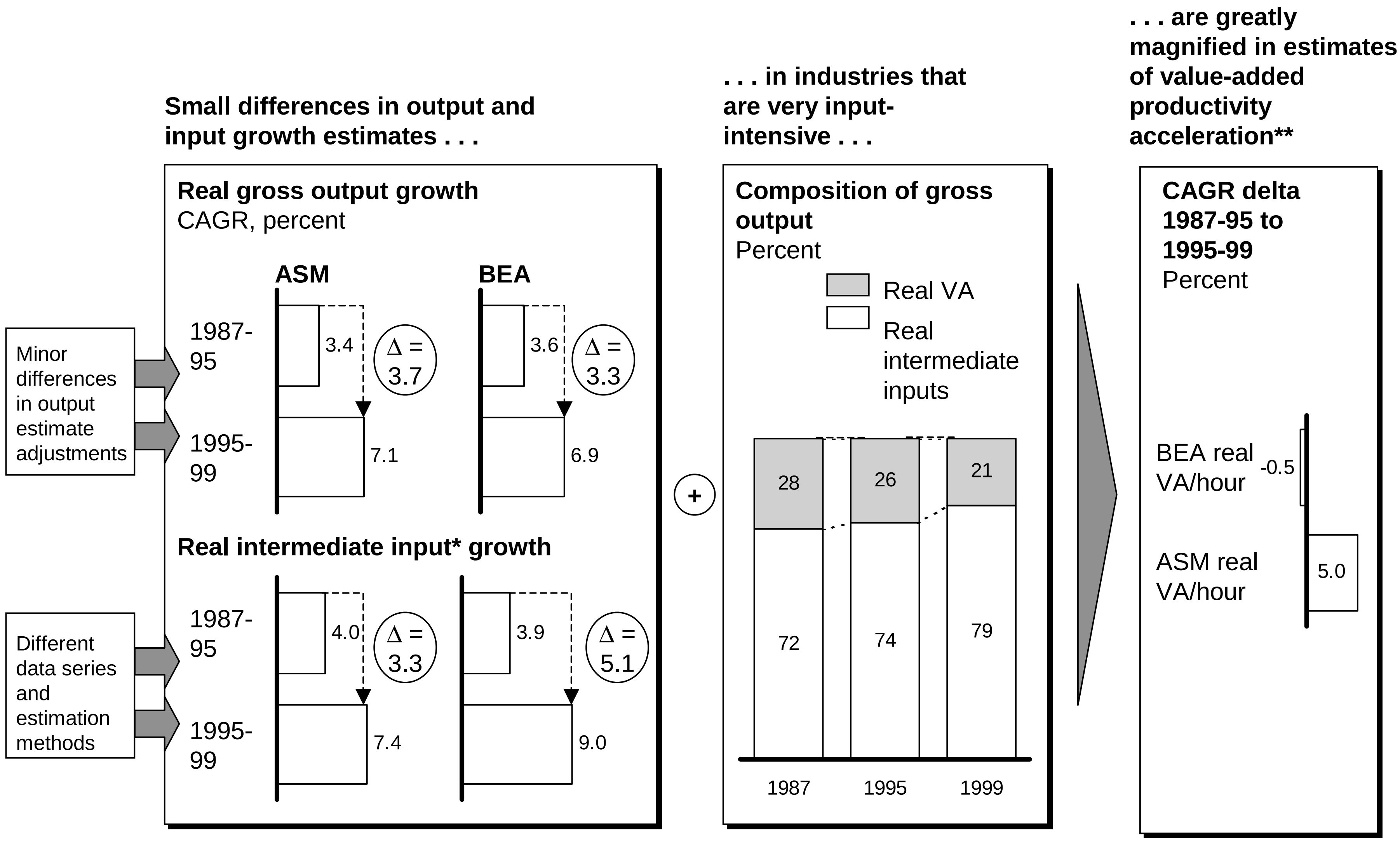
AUTOMOTIVE PENSION FUNDING MAY NOT HAVE BEEN REFLECTED IN PROFIT LINE, OVERSTATING PRE-1995 VALUE-ADDED GROWTH



Source:BEA; Interviews with BEA and McKinsey automotive practice; MGI analysis

Exhibit 5

SMALL OUTPUT AND INPUT DIFFERENCES CAN MAGNIFY IN VALUE-ADDED ESTIMATES



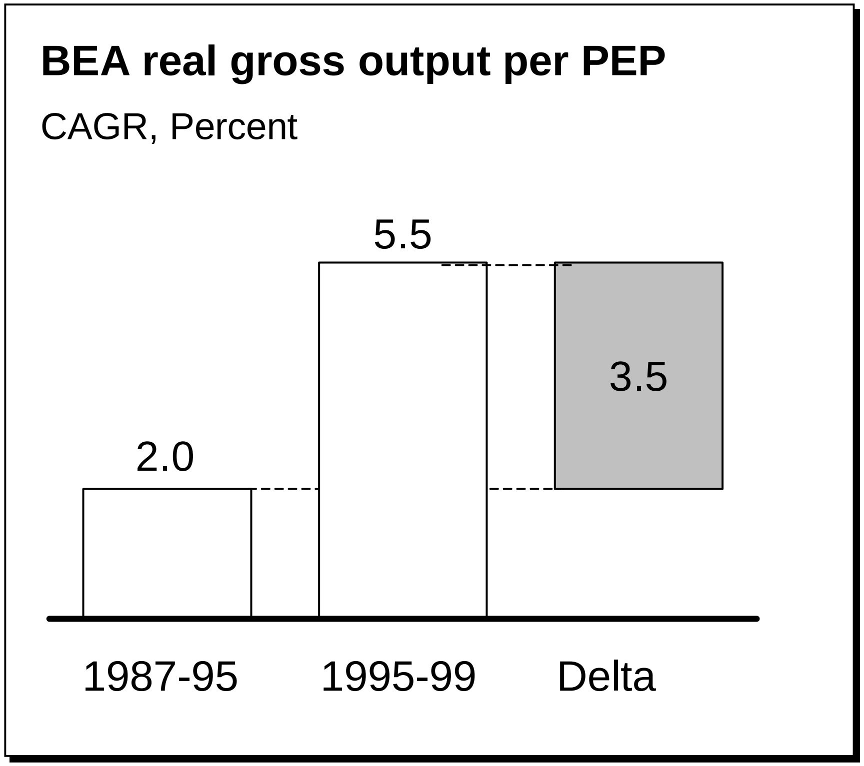
* BEA intermediate input estimates included purchased services and COGS, ASM intermediate inputs include COGS only

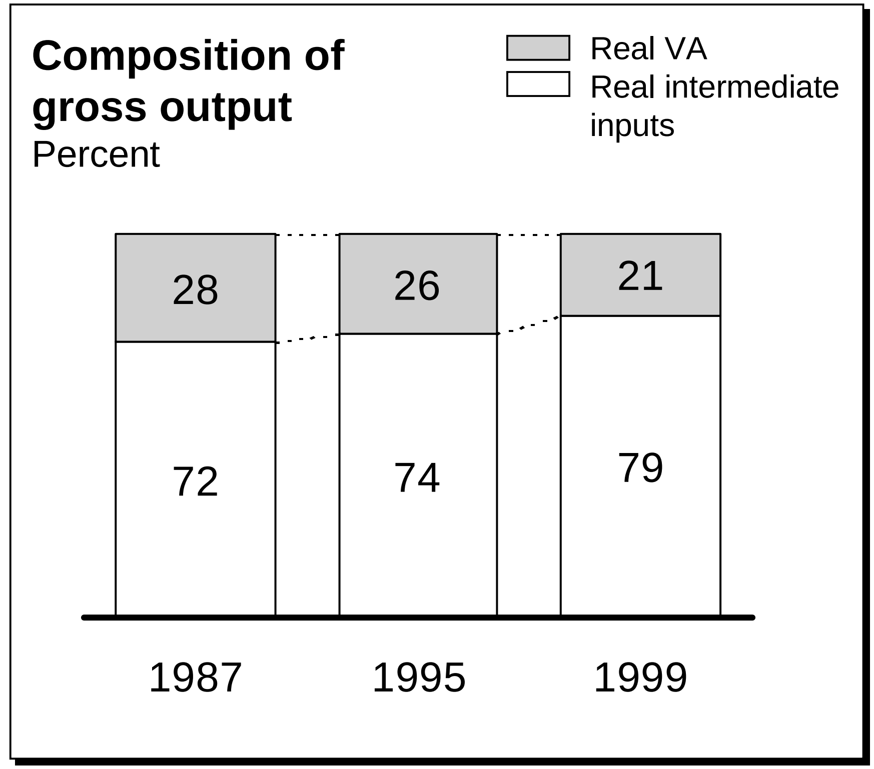
** Hours estimates are similar between data sources

Source: BEA; BLS; 1987-99 Annual Survey of Manufacturing; MGI analysis

Exhibit 6

GROSS OUTPUT ESTIMATES SUGGEST ACCELERATION, BUT SHOULD BE AVOIDED BECAUSE OF HIGH (AND INCREASING) LEVEL OF OUTSOURCING

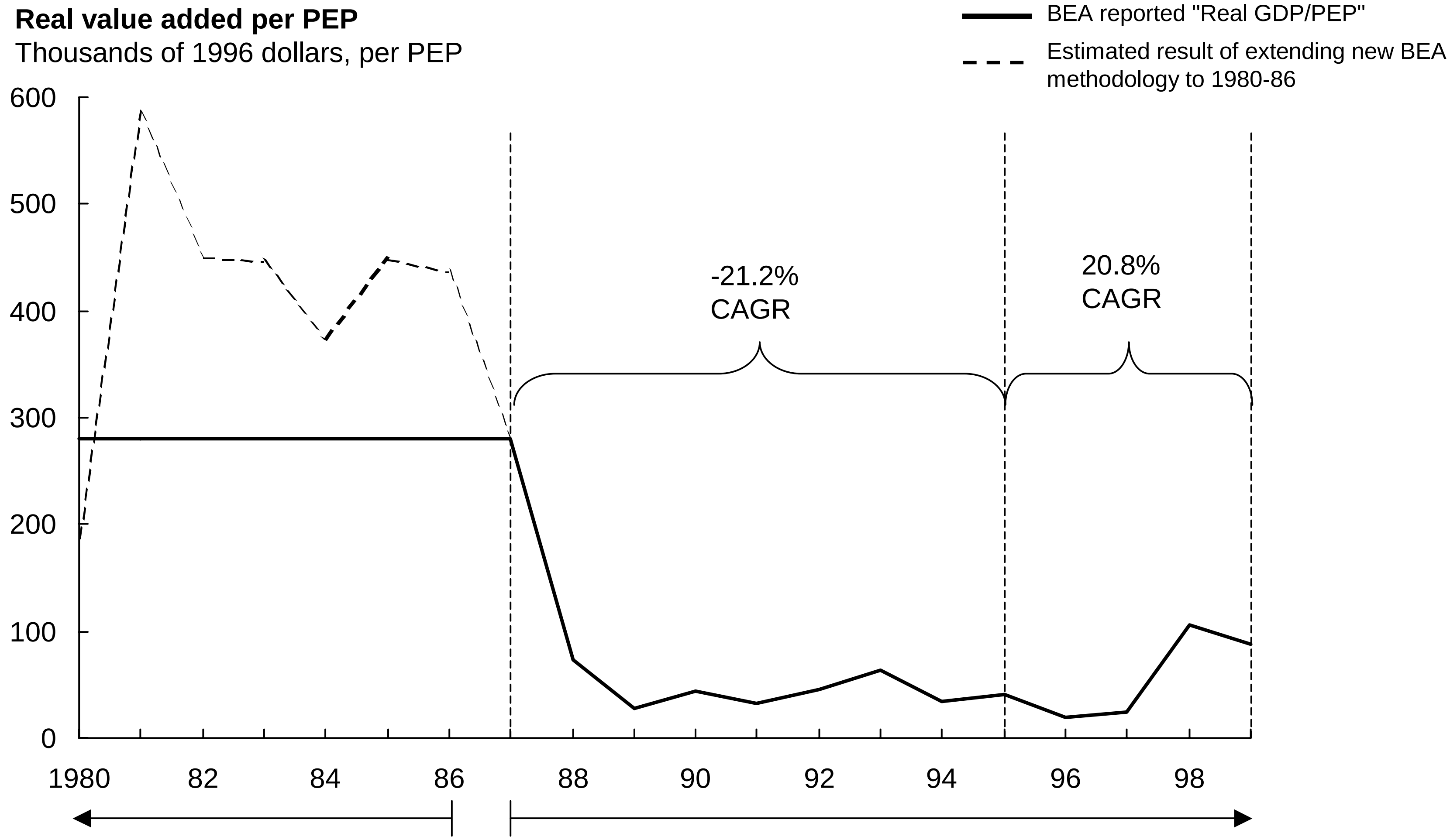




Source:BEA; MGI analysis

Exhibit 1

THE PRODUCTIVITY GROWTH RATE OF HOLDINGS AND OTHER INVESTMENT OFFICES HAS DRAMATICALLY INCREASED



Old Methodology, 1986 back
Labor productivity assumed to be constant, with level benchmarked to 1987*

New methodology, 1987 forward
Implicit price index, estimated based on price changes in wages, salaries, and depreciation

* BEA felt there was insufficient data to extend the new methodology to the GDP-by-industry data set of 1947-87

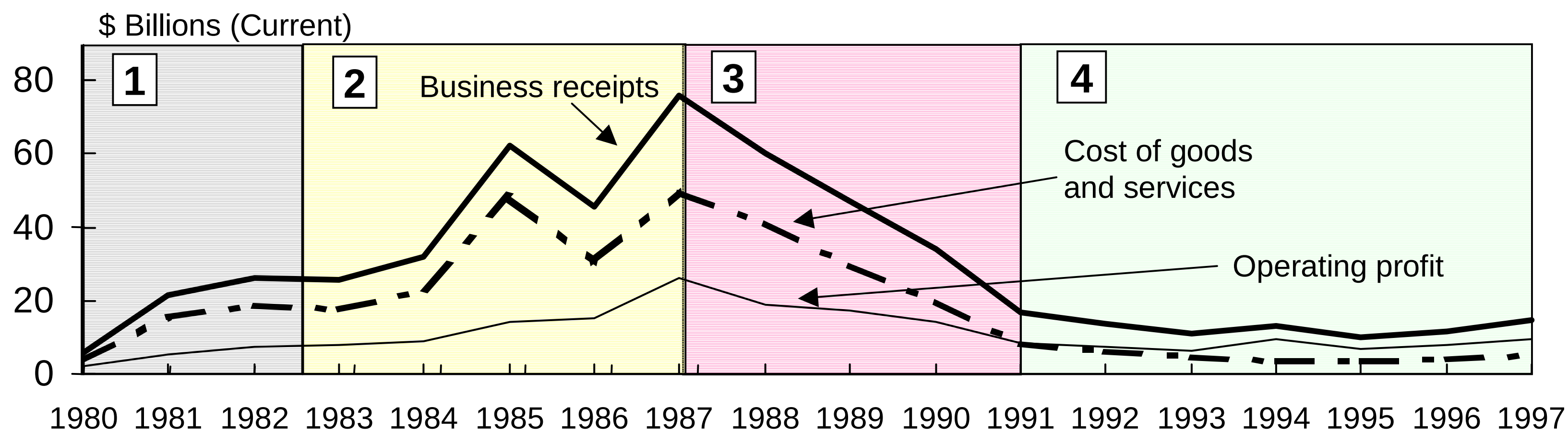
Source: BEA; mgi Analysis

Exhibit 2

IRS' RECLASSIFICATION OF HOLDING COMPANIES INTO OTHER SECTORS APPEARS TO CAUSE THE 1987-1988 GDP DROP

Theory

1. Historically, holding companies in sector were mostly pure – their receipts were almost entirely interest, dividends, and capital gains
2. IRS observed an increase in operating holding companies in mid 1980's (utilities, banks* that had business receipts)
3. IRS began reclassifying operating holding companies with large business receipts into other sectors
4. Screening became automated (done on-line, with more consistent and strict set of criteria) in 1991



Effect: The IRS data are used to generate the GDP data, but the PEP data comes from Census/BLS. Hence, the numerator significantly decreases, while the denominator continues its typical growth – resulting in a massive measured productivity drop

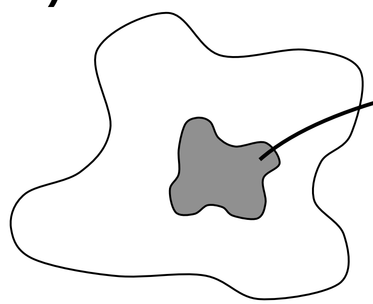
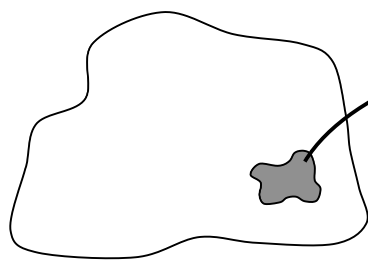
* Bank holding companies should, in theory, be excluded from sector - IRS indicated that this was not always the case

Source: IRS Source book to the Statistics of Income, IRS/BEA interviews; MGI Analysis

Exhibit 3

1997 GDP JUMP MAY ALSO RESULT FROM RECLASSIFICATION ISSUES AS IRS MOVED FROM SIC TO NAICS

1998 IRS returns — **Examples of difficult mapping**

Major filing group (NAICS)			1987 SIC group
813 Religious, grantmaking, civil, professional, similar organizations		Estimated 40-80% of 813 filings	6732 Trusts
523905 Securities and commodity exchanges and other financial investment activities		Estimated 5-25% of 523905 filings	6799, 6733 Venture capital, trusts

- IRS relied on difficult mapping from NAICS to old SIC 67
- Likely that, given small sector size, errors introduced by mapping were significant
- May also explain why 1998-99 saw small change but remained at a high level
- 2 mappings chosen as examples – IRS would need to make approximately 8 such nontrivial, estimated mappings for the sector

Source: IRS Source book to the Statistics of Income; Census NAICS to SIC conversion; BEA, IRS interviews; McKinsey Analysis

Glossary of terms used

Term	**Definition**
Acceleration	An increase in the annual growth rate of labor productivity from the 1987-95 period to the 1995-99 period. The acceleration is typically measured in terms of percent point difference between the 1987-95 and the 1995-99 labor productivity growth rate. In this report, the words 'acceleration' and 'jump' are used interchangeably.
Aggregate	Total for the whole economy (including all sectors).
BEA	Bureau of Economic Analysis, US Department of Commerce.
BLS	Bureau of Labor Statistics, US Department of Labor.
Business cycle	Economy-wide fluctuations in output, incomes, and employment.
Capital	1. The equipment and structures used in the production process 2. The funds to finance the accumulation of equipment and structures.
Capital deepening	An increase in capital per employee (one of the sources of growth in output from the growth accounting framework).
Capital intensity	Capital stock (of IT or other types of capital) per worker, unless defined otherwise.
Contribution	The portion of aggregate (sector) productivity growth or growth acceleration that is attributable to a specific industry (sub-sector or firm). This is calculated using the contribution analysis described in the "Objectives and Approach" chapter.
CPI	Consumer price index. A measure of the overall level of prices that shows the cost of a fixed basket of consumer goods relative to the cost of the same basket in a base year.
CRM	Customer Relationship Management. Refers to IT-enabled efforts to profile and segment the customer base, and to increase marketing effectiveness by tailoring campaigns to specific segments.

Term	**Definition**
Cyclical	Moving as output, income, and employment change over the business cycle.
Deflator	A price index; used to convert nominal numbers to quality adjusted output measures.
Demand shocks	Exogenous events that increase or decrease the level of aggregate demand in the economy.
Double deflation	Method used to calculate a deflator (price index) for value added which takes into account changes in both output and input prices.
GDP	Gross Domestic Product. Calculated by the BEA as the sum of value added across all of the sectors of the economy.
GMS	General Merchandise. A subsector of retail trade.
Growth accounting	Divides the growth in output of the economy into three different sources: increases in capital, increases in labor and "Solow residual"(increases in total factor productivity).
Holdings	Holding and other Investment Offices (SIC 67). Primarily composed of “Real Estate Investment Trusts” (REITs), “Regulated Investment Companies” (RICs), and “other holding and investment companies (except bank holding companies).
IT	Information technology. In this report, IT refers specifically to computer hardware, computer software, and communications equipment.
IT paradox	Refers to the Robert Solow's 1987 comment (also known as the 'Solow paradox') that - “you can see the computer age everywhere but in the productivity statistics.” The observation that IT has grown dramatically without a commensurate increase in productivity growth.
IT producing sectors	Electronic and Electric equipment (SIC 36) and Industrial Machinery and Equipment (SIC 35).
Jump	See 'acceleration'.

Term	Definition
Jumping sectors	1. Generally speaking, sectors which experienced an increase in the rate of productivity growth rate between two periods. 2. Used in specific instances in this report to refer to the six sectors contributing the bulk of the acceleration in productivity growth from 1987-95 to 1995-99.
Labor economies of scale	See Objective and Approach chapter, Appendix B
Labor skills	See Objective and Approach chapter, Appendix B
Measurement issues	See Objective and Approach chapter, Appendix B
Multi-factor productivity	See total factor productivity.
Mix shift effect	Changes to the productivity growth rate due to differences in relative employment growth rates and relative productivity levels between industries. For example, if an industry which has higher productivity than the US average grows as a share of the economy (i.e. employment rises faster than the US average), overall US productivity will rise – even if productivity growth in the sector does not increase. See Objective and Approach chapter, Appendix A
Nominal	Measured in current dollars; not adjusted for inflation.
OFT	Organization of functions and tasks. The way in which production processes and other key functions (product development, sales, marketing) are organized and run.
Output mix	See Objective and Approach chapter, Appendix B
Paradox sectors	Sectors of the economy where IT investment has grown dramatically without a commensurate jump in productivity growth.
Product market regulation	See Objective and Approach chapter, Appendix B
Productivity	Unless specifically noted, productivity in this report refers to labor productivity (rather than total factor productivity).

Term	Definition
Real	Measured in constant dollars; adjusted for inflation.
Sector	As defined by the Bureau of Economic Analysis. The BEA lists 60 individual sectors in the US private sector; this report sometimes refers to the 'US nonfarm private sector' which contains 59 BEA sectors.
SIC	Standard Industrial Classification, a system used by the US Bureau of the Census to categorize firms by business type. Recently, US statistical agencies have moved to a new system (the NAICS classification).
Structural	Unrelated to the business cycle / unaffected by cyclical demand factors.
Substitution to higher value goods	Increase in proportion of consumption of higher value goods resulting from changes in relative prices or increase in wealth.
Supply shock	Exogenous events that shift the aggregate supply curve
Sustainable	Expected to continue over the 2001-2005 period.
TFP	Total factor productivity. Output growth that cannot be accounted for by growth in inputs; also known as the "Solow residual". See Objectives and Approach, Appendix A
Value added	The value of a firm’s output minus the value of the intermediate goods the firm purchased. Corresponds to the sum of operating profits and wages.
WMS	Warehouse management systems